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**MOLLUSCA OF THE SOUTHWESTERN STATES, I: Urocoptidæ; Helicidæ of
Arizona and New Mexico.**

BY HENRY A. PILSBRY.

In these papers the mollusks collected by Mr. James H. Ferriss and the writer in the expedition made in 1903 and by Mr. Ferriss in two visits to Arizona in 1902 and 1904 will be discussed. The present contribution deals chiefly with Mr. Ferriss' researches in Arizona, where an extraordinarily rich and varied snail fauna was found in the canyons of the Chiricahua and Huachuca Mountains. In the study of these materials I have worked over many specimens received from the late E. H. Ashmun, who first made known to us the richness of the Arizona snail fauna, and from Prof. T. D. A. Cockerell, whose unceasing labors on the fauna and flora of New Mexico are familiar to all naturalists. The treatment of the genus *Ashmunella* has been made practically monographic.

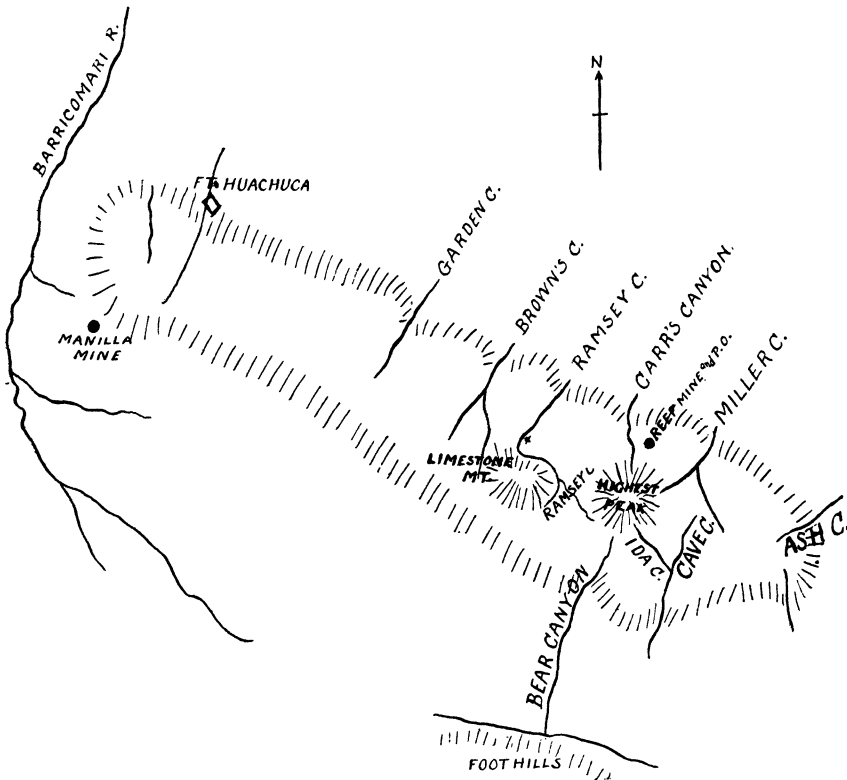
It is unfortunate that no good topographic survey of southern Arizona has been published. It is extremely difficult at present to determine some localities given by previous naturalists, or to clearly indicate the positions of those explored by Mr. Ferriss. The accompanying sketch of the canyons explored in the Huachuclas makes no pretensions to cartographic accuracy beyond showing the relative positions of the localities mentioned in the text. From Fort Huachuca to Ramsey Canyon is 10 miles; to Carr Canyon 14, and to Miller Canyon 20 miles. Manilla mine is 6 miles from Fort Huachuca. The range is about 30 miles long and 6 wide.

Of the Chiricahuas, it may suffice to say that Bar or Bearfoot Park is on the summit, and is believed to lie at 8,500 feet elevation. There was a sawmill there in 1904. From it toward the southwest Sawmill Canyon leads, and Cave creek flows down from the opposite side. This must not be confused with Cave Creek Canyon in the Huachuclas. Fly Park, the type locality of *Ashmunella chiricahuana*, is on the same mountain, farther south about two(?) miles. Cave creek is 30 miles from Nine-Mile Canyon, and 20 miles from Fort Bowie. Mr. Ferriss has given notes on the general conditions of collecting and on the country in the *Nautilus* for September, 1904.

Some considerations of general interest to evolutionists are touched

upon in the discussion of the composite nature of snail colonies (p. 226), since the conclusions reached from molluscan studies apply equally to communities of other comparatively sedentary animals.

Throughout the preparation of this paper I have had the coöpera-



Sketch of Huachuca range, by J. H. Ferriss.

tion of Mr. J. H. Ferriss. I would also gratefully acknowledge assistance lent by Dr. Wm. H. Dall, in the comparison of various species of *Holospira*, etc., with those described by him.

The figures of shells were photographed and those of soft anatomy drawn by the author.

Family UROCOPTIDÆ Pils.

This family is represented in the Southwest by members of two very distinct subfamilies: EUCALODIINÆ with the genus *Holospira*, and MICROCERAMINÆ with the genus *Microceramus*.

Holospira is an old genus, containing several highly specialized phyla. Our species fall into five groups as indicated below. The subgenera were formerly defined by the internal lamellæ alone; but these are in some cases of less significance than the general form and sculpture.

A.—Last whorl distorted, its last half turning sinistrally.

I.—Internal column rather large, smooth throughout; last whorl sinuous, turning sinistrally. Aperture oblong, with a strong fold within the right margin and a vertical columellar callosity in the throat. METASTOMA Strebel. One species, *H. roemeri*.

B.—Last half of the last whorl straightened, normal.

II.—Internal column small, smooth and simple throughout, or with a small axial lamella in the last whorl; very slender below, slightly wider above. Shell rather large, 19 to 29 mm. long, the individual whorls comparatively high; the last one or two more coarsely sculptured than the intermediate ones. Number of whorls much less than the number of millimeters in the length of the shell. *Haplocion* Pils. Species, *H. pasonis* Dall, *H. hamiltoni* Dall.

III.—Penultimate whorl with a short, stout lamella on the axis, and a weaker one on the basal wall. Number of whorls decidedly less than the number of millimeters in the shell's length. *Distomospira* Dall. Species, *H. bilamellata* Dall.

IV.—Internal column moderate, one-fourth to one-sixth the diameter of shell. Shell 9 to 18 mm. long in known species, *compactly coiled*, ribbed or striated, the whorls short, their number about equal to the number of millimeters in the length of the shell, or exceeding that number. A short axial lamella is present within the penult. whorl, and sometimes short basal or parietal lamellæ. *Bostrichocentrum* Strebel. Type *H. tryoni*.

V.—Cavity of the penultimate whorl obstructed by four strong lamellæ, axial, basal, parietal and palatal. HOLOSPIRA s. str. Species, *H. goldfussi* Mke.

In addition to the species noticed below, the following species of *Holospira* are known from north of the Mexican boundary:

H. (Bostrichocentrum) pilsbryi Dall, rather doubtfully recorded from New Mexico or Arizona, without definite locality, and known to inhabit the Mexican state Puebla.

H. (Distomospira) bilamellata Dall, from the top of Hacheta Grande Mountain, Grant county, New Mexico.

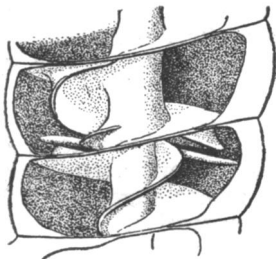
H. (Haplocion) pasonis Dall, from Mule Canyon, El Paso county, Texas.

H. (Haplocion) hamiltoni Dall, from Rio Grande Mountains, Brewster county, Texas, at an elevation of 3,500 feet, living on *Selaginella lepidophylla*, a common and conspicuous moss of western Texas.

Subgenus HOLOSPIRA (typical group).

Holospira goldfussi (Menke). Pl. XXVI, figs. 1-5.

Like *H. roemeri*, this species belongs to the hill country bordering the Lower Cretaceous area in Texas. Mr. Ferriss and the writer found it above San Marcos, Hays county, Texas, in the flood-débris of Sinking Spring, and on ledges of its bordering limestone cliff. This is farther northeast than the species has hitherto been found, for I have no doubt that the locality "Dallas," cited by Strebel, is an error. It is abundant under stones at the foot of the cliffs along the Guadalupe river, about six miles above New Braunfels, Comal county. Also nearer the town, in the hills above the head of Comal creek.



Internal structure of *H. goldfussi*.

It varies a good deal in size:

Length	14,	diam.	4	mm.;	whorls	14 $\frac{3}{4}$.
"	10,	"	3.9	"	"	10 $\frac{1}{2}$.
"	11.5,	"	3.1	"	"	12 $\frac{1}{2}$.

The specimens figured are from the Guadalupe. New Braunfels is probably the type locality.

At the Hondo river, two miles north of Hondo, Medina county, in the drift-débris, we also found *H. goldfussi*. This is the extreme western range of the species as far as we know. It did not occur in the Devil's river region, on the Pecos or westward.

Subgenus BOSTRICHOCENTRUM Strebel.

All of the species have a small, short lamella on the axis in the last part of the penultimate whorl, sometimes almost obsolete, and some of them have a very weak basal or parietal lamella, or both. These lamellæ are always very much smaller and lower down than those of typical *Holospira* (*goldfussi*, etc.). The variations are as follows:

Species.	Lamellæ present.		
<i>H. ferrissi</i> :	axial,	parietal,	basal.
<i>H. arizonensis</i> :	axial,	parietal,	.....
<i>H. bilamellata</i> :	axial,	.....	basal.
<i>H. mearnsi</i> :	axial,	.....	.....

In *H. crossei* the axial lamella is so weak as to be readily overlooked.

Part of the species of this group have the terminal cone short, others having it very long; *H. crossei* being somewhat intermediate. Otherwise they are very similar externally. They may be grouped thus:

Cone of the spire short, rapidly tapering.

Three internal lamellæ	<i>ferrissi</i>	} Ribbed throughout.
Two internal lamellæ	<i>arizonensis</i>	
	<i>crossei</i>	} Median whorls smoothish.
	<i>cionella</i>	
One internal lamella.....	<i>Spire slowly tapering.</i>	} Ribbed throughout.
	<i>mearnsi</i>	
	<i>regis</i>	
	<i>chiricahuana</i>	
	<i>cockerelli</i>	
		Median whorls smoothish.

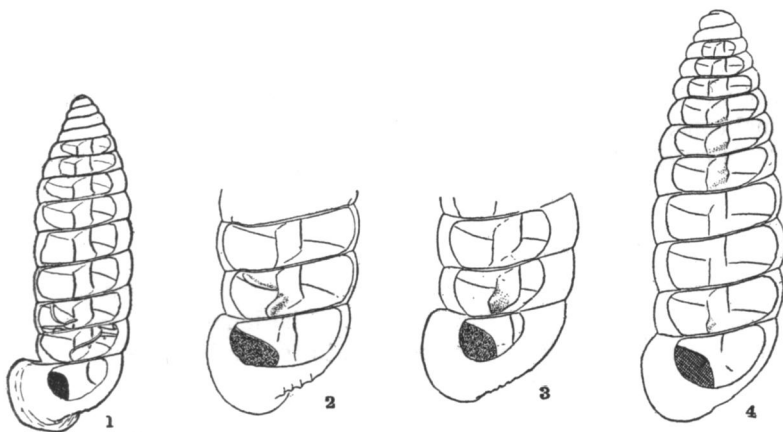


Fig. 1.—*Holospira goldfussi*. 2.—*H. ferrissi*. 3.—*H. cionella*.
4.—*H. chiricahuana*.

***Holospira ferrissi* n. sp.** Pl. XXVII, figs. 22-25.

The shell is rimate but imperforate, short and cylindric, rather thin, and very pale brownish-corneous. Whorls $9\frac{1}{2}$ to 11, the first whorl wider than the second, both of them smooth; all the rest of the whorls are regularly, evenly and closely rib-striate, the riblets as wide as their

intervals or a little narrower, except on the last whorl, where the sculpture is a little coarser and irregular. The whorls are all convex, the last 4 or 5 forming the cylindric portion, the preceding whorls forming the terminal cone, which is about one-third the total length of the shell. The last whorl is pinched or compressed laterally, but the very short straight "neck" is full again, and carries the aperture very shortly free. The aperture is rounded, but a little irregular, the upper margin being somewhat straightened. The thin peristome is narrowly expanded.

The internal pillar is rather large and of equal calibre in the cylindric portion of the shell. At the end of the penultimate and beginning of the last whorl there is a short strong and blunt lamella on the pillar below the middle, a low, short lamella on the parietal wall and another on the basal wall. There is no palatal lamella.

Length 7.5 to 9, diam. 3 mm.

Manilla mine, Huachuca Mountains.

This is a very short, thick-set species, unlike all others known in its internal armature. The even ribbing and short terminal cone are also characteristic. It is closely related to *H. arizonensis* Stearns, from Dos Cabezas, a place west of the Chiricahua range and not far from one of the localities of *H. ferrissi*; but besides the slight difference in internal structure, *H. arizonensis* differs in being slightly larger with more whorls, and the riblets are subobsolete on the cylindric portion of the shell, while in *H. ferrissi* they are even stronger there than on the terminal cone.

This species occurred also at Fort Bowie, Arizona, where the shells average a trifle larger:

Length 7.5, diam. 3 mm., whorls $9\frac{1}{2}$.

Length 10, diam. 3 mm., whorls $11\frac{1}{2}$.

This species seems to partially connect typical *Holospira* with the sections *Eudistemma* and *Distomospira*. The lamellæ are far shorter and weaker than in the typical section, in fact, might easily be overlooked.

***Holospira arizonensis* Stearns.**

This shell is cylindric with a *short, ribbed, terminal cone*. The *median whorls are smoother*, only obscurely sculptured, and the last whorl is ribbed. Whorls 12 or 13.

The internal axis is moderately large, and there is a short lamella on the axis and one on the parietal wall or roof in the penultimate whorl.

Length 12.5 to 13, diam. 4 mm.

Southeast Arizona, at Dos Cabezas, Cochise county.

This species resembles *H. ferrissi* and *H. cionella* in shape, but differs by its larger size and the obsolete sculpture of the median whorls, as well as by the slightly different internal lamellæ. It is known by the original specimens only.

Holospira cionella n. sp. Pl. XXVII, figs. 30-33.

The shell is very shortly rimate but imperforate, cylindric with a short terminal cone, corneous-white. Whorls $11\frac{3}{4}$ to $12\frac{1}{2}$, convex, the first $2\frac{1}{2}$ smooth, second whorl narrow, the first wider and bulging. Subsequent whorls are sharply and closely ribbed throughout. The last whorl is compressed laterally, tapering downward, the base white, rounded and prominent; it is contracted, descends a little, and is shortly free in front. The aperture is very shortly ovate, the peristome thin and narrowly expanded. The axis is moderately large and cylindric, with a low, blunt lamella at the end of the penultimate and beginning of the last whorl.

Length 10 to 12, diam. 3 mm.

Fort Bowie, Cochise county, Arizona.

The uniform ribbing throughout, the cylindric shape and short terminal cone are the prominent features of this species, which groups with *H. mearnsi*, *cockerelli* and *chiricahuana*.

Holospira crossei Dall. Pl. XXVI, fig. 8.

This species is closely related to *H. cockerelli*, but differs by its wider shorter form and much shorter terminal cone of the spire. At the end of the penultimate whorl there is a very weak prominence upon the axis near the basal wall, hardly to be called a lamella. The tapering portion of the spire is ribbed, the cylindric portion smoothish.

Length 11, diam. 3.7 mm.

New Mexico; top of Hacheta Grande Mountain, Grant county, with *H. mearnsi* and *H. bilamellata*.

Figured from one of the original lot for comparison with the related species. It has not again been found.

Holospira mearnsi Dall.

The spire tapers gradually and is ribbed, the ribs somewhat weaker on the intermediate whorls, stronger again at the base. Whorls 14. The axis is small, with a short, strong lamella near the base in the penultimate whorl, as in *H. cockerelli* and *H. regis*. Length 14.5 mm.

Southwestern New Mexico, on the top of Hacheta Grande Mountain, Grant county, with *H. crossei*, a smaller species with less projecting aperture.

Holospira regis Pills. and Ckll., n. sp. Pl. XXVI, fig. 7.

Shell small, the lower half cylindric, upper half slowly tapering in a long cone to the obtuse apex. Whorls $12\frac{2}{3}$, all convex, the first two smooth, the following whorls of the tapering portion of the spire rather strongly, obliquely rib-striate, the riblets slightly narrower than their interstices; the penultimate and next earlier whorls are more closely and a little more finely sculptured, but on the last whorl the riblets become stronger again. The last half of the last whorl is compressed laterally, sloping to an almost subangulate but very obtuse base. Near the end the whorl becomes free, descends a little, and is flattened and excavated above. The aperture is obliquely piriform, its contour being compressed near the upper outer angle. The peristome is free throughout, expanded, the columellar and upper margins a little reflexed. The upper margin is a little dilated inwardly. The axis is small and slender. Near the end of the penultimate whorl there is a short, stout lamella on the axis near the basal wall.

Length 10.8, diam. of cylindric portion 3.3 mm.

Near Kingston, Sierra county, New Mexico. Type No. 87,208, A. N. S. P., collected by Mr. O. B. Metcalfe.

This species is about the size of *H. chiricahuana*, which, however, differs in the less projecting last whorl, contracted behind the lip, and in the smaller, differently shaped mouth. The more closely related *H. mearnsi* is larger with more whorls, but it is not unlikely that specimens intermediate in these respects will be found. Several broken shells of *H. regis* indicate dimensions smaller than those of the type.

Holospira cockerelli Dall. Pl. XXVI, fig. 6.

Holospira (Haplostemma) cockerelli Dall, Nautilus, XI, p. 61, October, 1897.

Shell cylindric below, the upper half tapering in a long, very slowly tapering cone to the obtuse apex. Whorls $13\frac{2}{3}$, convex, the upper ones more so. The first $2\frac{1}{2}$ form the smooth embryonic shell, the second of them being wider and more swollen than the following one. Post-embryonic whorls of the tapering spire rather strongly rib-striate, the riblets oblique, narrower than the rather wide intervals. On the cylindric portion the riblets weaken to irregular growth wrinkles, but the base and the last half of the last whorl are strongly ribbed again. The last whorl is well rounded below, projects forward but very shortly, and descends to the mouth. The aperture is obliquely rounded-piriform, produced at the upper outer angle. Lip well expanded, the columellar and upper margins narrowly reflexed. The axis is slender. There is a low weak lamella on the axis in the last part of the penultimate whorl, close to the basal wall.

Length 12.1, diam. 3.5 mm.

The type was found in the débris of the Rio Grande at Mesilla, New Mexico. The specimen described above is from near Kingston, Sierra county, New Mexico, collected by O. B. Metcalfe, sent by Prof. T. D. A. Cockerell.

H. cockerelli differs from the related *H. regis* and *H. mearnsi* chiefly by the smoothness of the intermediate whorls. It is not improbable that the original specimen found in the flood-débris of the Rio Grande was washed down from the region around Kingston, as Prof. Cockerell suggests to me.

Holospira chiricahuana n. sp. Pl. XXVI, fig. 9; Pl. XXVII, figs. 26-29.

Shell imperforate, shortly rimate, cylindric, the upper half tapering, thin, pale brownish-corneous. Whorls 11 to 12, all convex, the first slightly bulging and wider than the second, both smooth, the following whorls sharply sculptured with close riblets a little narrower than their intervals. The last whorl is compressed laterally, tapering downward, the base prominent and white. It is very shortly straightened and a little contracted in front, not carrying the aperture in front of the ventral plane of the shell, though the peristome is very shortly free. The aperture is shortly ovate, nearly round, the peristome very narrowly expanded.

The axis is moderately large and of nearly equal calibre throughout, and at the end of the penultimate and beginning of the last whorl there is a low, short obtuse lamella below the middle on the axis.

Length 10, diam. 3 mm.; whorls 12.

“ 8.5, “ 2.9 “ “ 11.

“ 8, “ 2.7 “ “ 11.

Cave Creek Canyon, Chiricahua Mountains, southeast Arizona. Also Fort Bowie, at the southeastern termination of the same range.

H. mearnsi Dall is a larger and smoother species. In *H. cockerelli* the sculpture is coarse on the early and last whorls only, the middle ones having a polished or at least smoothish surface with quite faint striation only. The spire in *H. chiricahuana* tapers more gradually than in most other species.

Some of the specimens from Fort Bowie are larger, length 13, diam. 3.25 mm.; whorls 14; and one from Cave Creek Canyon, the type locality, measures length 13.5, diam. 3.2 mm.; whorls 14. The riblets are strong and uniform throughout in all the specimens.

Subgenus METASTOMA Strebel.

Holospira roemeri (Pfr.). Pl. XXVI, figs. 10-18.

This peculiar snail inhabits the hilly border of the 1,000 foot elevation which roughly defines the southeastern limit of the Lower Cretaceous area in Texas. It has not been observed northeast of New Braunfels. Thence it has been traced westward in Medina county, and near the Rio Grande, at Devil's river and the Pecos. We know nothing of its distribution northward upon the "Edwards Plateau," since only its lower scarps have been explored. Westward we have it from El Paso, where Ferriss got specimens on Franklin Mountain in 1902; and in New Mexico Rehn and Viereck found it in Alamo Canyon, near Alamo-gorda, Otero county, in the eastern range of the Cordillera.

The specimens from El Paso are large, like those of the Pecos. An average one measures, length 15.5, diam. 4.5 mm.; whorls 14. Those from Alamo Canyon are smaller, 12 to 13 mm. long, 4 wide. They vary but little in size.

In the canyon of the Pecos river, in Valverde county, Texas, above and below the High Bridge (figs. 16, 17, 18), the specimens are larger than at any other locality, and have more whorls for their length. The base is narrowly and deeply excavated, and the last whorl is very strongly sigmoid and projects in a longer neck than in the shells of central Texas. Most of the shells measure 15 to 16 mm. long, 4 wide, few being larger or smaller.

Length 17, diam. 4.7 mm.; whorls $15\frac{1}{2}$.

" 16, " 4 " " $15\frac{1}{3}$.

" 15.5, " 4 " " $14\frac{3}{4}$.

" 15, " 4 " " 15.

" 14.9, " 4.5 " " $14\frac{1}{3}$.

In the drift-débris of Devil's river, Valverde county, Texas, about four miles from its mouth, a large majority of the shells are 14 to 15 mm. long, with $14\frac{1}{2}$ to $15\frac{1}{2}$ whorls. The base and neck are like the larger shells of the Pecos.

Length 15.2, diam. 4 mm.; whorls 16.

" 15, " 4 " " $15\frac{1}{2}$.

" 14.9, " 3.9 " " $15\frac{1}{3}$.

" 14.9, " 3.8 " " $15\frac{3}{4}$.

" 14.3, " 4.2 " " 15.

" 13.8, " 4 " " $14\frac{1}{2}$.

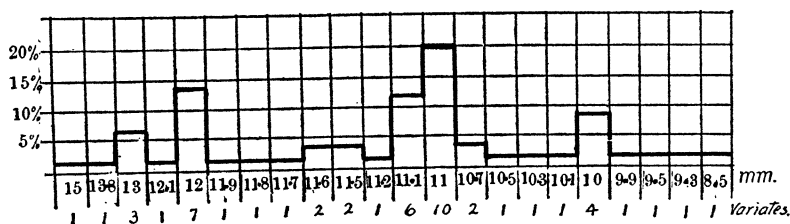
" 14, " 4.1 " " $14\frac{1}{2}$.

" 12.9, " 4 " " $13\frac{3}{4}$.

Hondo river, two miles north of Hondo, Medina county, Texas (figs. 10-15). The shells are much smaller than in western Texas, usually 11 to 12 mm. long, and the diameter is generally less than 4 mm. A large proportion of the shells have "overhanging" upper whorls. They were picked out of river-débris, and probably came from the hill country some miles farther north. The measurements of fifty adult shells, all the perfect ones I found, follow:

Length	15	13.8	13	13	12	12	12	11.7	13
Diam.	3.8	4	3.8	3.7	3.9	3.6	4	3.3	4
Whorls	15	14½	13½	13½	12	13	12¾	12.5	13
Length	11.8	12	11.9	11.5	12.1	12	11.5	11.1	12
Diam.	3.8	4	3.9	4	4	4	3.5	4	4
Whorls	12½	12¾	12¾	12½	13	12½	12¾	12	12¾
Length	12	11.2	11.6	11	11	11.1	11.1	11.1	11
Diam.	4	4	3.9	3.9	3.8	3.8	3.9	4	3.8
Whorls	12½	12½	12½	12½	12½	12½	12	12	12½
Length	11.6	11	11	11	11.1	11	11	11.1	10.1
Diam.	3.6	3.8	3.5	4	4	3.9	3.6	3.9	3.8
Whorls	12½	12	12½	11½	12½	12	12	12½	12
Length	11	10.5	11	10.3	10.7	10.7	10	10	10
Diam.	3.9	3.6	3.5	3.8	4	3.8	3.5	3.8	3.5
Whorls	12	11½	13	11¾	11½	11½	11½	11½	11¾
Length	10	9.9	9.5	9.3	8.5 mm.				
Diam.	3.6	3.8	3.3	4.8	3.9	"			
Whorls	11¼	11	11¼	10½	10				

The lengths give the following curve, which, although of no great value on account of the small number of variates, is given for what it is worth.



Genus **MICROCERAMUS** Pils. and Van.

Nautilus, XI, p. 107; Proc. Acad. Nat. Sci. Phila., 1898, p. 281; Manual of Conchology, XVI, p. 151.

Microceramus comprises the species formerly referred to *Macroceramus* in works on snails of the United States. These, with their Antillean relatives, prove to have no near relationship to true *Macroceramus*, which belongs to a different subfamily, the *Urocoptinæ*, very unlike the *Microceraminæ* in dentition.

Microceramus texanus (Pils.). Pl. XXVI, figs. 19-21.

A species of the hill country inhabited by *Holospira goldfussi*, with which it is found. It was originally described from New Braunfels, Comal county, but the range has been extended both north and south by Mr. Ferriss and myself. Specimens were taken in the drift of the Hondo river, two miles north of Hondo, Medina county; in Comal county, on the rocky, wooded hillside above the head fountains of Comal creek, near New Braunfels, and along the Guadalupe river, some miles above (figs. 19-21). These last are the largest and best developed shells, but vary in size:

Length 10.5, diam. 3.5 mm.

" 8.3, " 3.5 "

" 8.3, " 3 "

The average is about 9 x 3.5 mm.

In the débris of Sinking creek, near San Marcos, Hays county, they are smaller:

Length 8, diam. 3.1 mm.

" 7.3, " 3 "

M. texanus is closely related to *M. mexicanus* (v. Mart.), a species extending from the State of Vera Cruz to Nuevo Leon and Tamaulipas, and to *M. floridanus* of Florida. The areas of the three are now widely separated.

Family **HELICIDÆ**.

The following genera of *Helicidæ* are represented in Arizona and New Mexico:

Ashmunella Pils. and Ckll.

Thysanophora Strebel.

Sonorella Pilsbry.

Polygyra Say.

Oreohelix Pilsbry.

The first three of these, though degenerate in their reproductive organs, are believed to belong to the *Belogona euadenia* of my classification of Helices, and are therefore more nearly related to the Californian and Mexican Helices than to those of eastern North America.

Thysanophora is represented by two species, noticed below.

The only *Polygyra* yet reported from New Mexico or Arizona is *Polygyra triodontoides* Bld., which has been reported from South Spring

creek, near Roswell, in the Pecos Valley, New Mexico (*Nautilus*, XIII, p. 84), but the specimens, now in my possession, proved to be a form of *P. texasiana*, near *P. t. texasensis*. This is farther west than any previous record of *P. texasiana*.

ASHMUNELLA Pils. and Ckll.

Pilsbry and Cockerell, Proc. Acad. Nat. Sci. Phila., 1899, p. 188; *Nautilus*, XII, p. 107; Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 107; Ancey and Murdoch, Journal of Malacology, VIII, 1901, p. 73.

Helicidæ with a *Polygyra*-like or *Triodopsis*-like shell, always umbilicate and with a reflexed or recurved lip; aperture with 0 to 4 teeth. Genitalia with, on the ♂ side, a short or moderate penis, an extremely long epiphallus, and an excessively short flagellum; ♀ side with a moderately long or very long spermatheca duct, but slightly or not dilated at the distal end; other organs as usual; no dart-sack, mucous glands or other accessory organs. Right eye-stalk retracted between the branches of the genitalia. Penis retractor muscle with a very long or double insertion near the base of the epiphallus, inserted distally on the lung-floor. Jaw ribbed. Teeth of the ordinary Helicid type, about 10 on each side being laterals.

Type *A. rhyssa miorhyssa*. All known species are from the mountains of New Mexico and southeastern Arizona.

Only two of the 15 species and 10 subspecies now known had been recognized prior to 1895, and but one of these was published at the time the last treatise on American land snails was issued, Binney's *Manual of American Land Shells*, 1885. The literature of the group is scattered through many volumes of several periodicals, and a large majority of the species have not been figured. In making substantial additions to the group, it seems timely to review and systematize the data accumulated.

The soft anatomy has proved to conform closely to the generic characters originally set forth. Ten species and varieties have now been dissected by myself and one additional by Mr. Murdoch, none of them diverging in any important respect. The proportions of the organs vary in the several forms, showing specific variation and affording valuable clues to the affinities of the species. To utilize these data it is necessary to give the measurements of the organs, readily obtained by pulling them out straight.¹ The measurements of the genitalia of ten species of *Ashmunella* follow:

¹ The comparative lengths of the organs are not materially altered by different degrees of contraction owing to different methods of preservation; and even the absolute dimensions are less affected than might be supposed. All but one of the dissections noticed herein were made from drowned specimens preserved in alcohol, with but little contraction.

Measurements of the Genitalia in Millimeters.

Species or subspecies	<i>mio- rhyssa</i>	<i>hypo- rhyssa</i>	<i>thom- soniana</i>	<i>porterae</i>	<i>dupli- cidens</i>	<i>prox- ima</i>	<i>angi- gyra</i>	<i>angu- lata</i>	<i>esuritor</i>	<i>chirica- huana</i>
Total length of penis, epiphallus and flagellum.....	41	40	about 28	34	31	37	31	42	35	73
Length of penis (swollen portion) ..					4.5	2.5(?)	6	1	2.2	4.5
From atrium to upper insertion of penial retractor.....	15	11		11	9	8		7.5	11.5	
Length of flagellum.....	1.5	1	—1	.5—.75	1	1.5	1.3	1.2	1	1.7
Length of vagina (measured from atrium to base of spermatheca duct).....					5.5	5	3	4.5	5.3	9
Length of the spermatheca and its duct.....	20.5	16	16.5	22	19.5	27	22	23	31	56
Length of spermatheca and duct as compared with the penis, epi- phallus and flagellum.....	50%	40%	60%	65%	63%	73%	70%	55%	90%	77%
No. of specimen supplying data....	73,557	77,869	77,870	76,789	87,024	86,498	83,269	87,015	87,023	87,021
Diameter of shell.....	16	18	13	15	12 to 13	12-13	13-14	13	15	18

The jaw and teeth of *Ashmunella* do not differ from those organs in *Sonorella*. The jaw is ribbed, the ribs variable and irregular, as is often the case in the Californian *Helices*. It is less strong and the ribs are less convex than usual in the jaw of *Polygyra*. The radula has from 24.1.24 to about 30.1.30 teeth. There are 9 to 12 lateral teeth. In nine of the ten species examined, both mesocone and ectocone are bifid on part of the marginal teeth. In *A. duplicidens* and *A. chiricahuana* the ectocone is usually simple, but on occasional outer marginals of the latter they are bifid, as in the other species. The number of teeth reckoned as laterals varies somewhat on different parts of the same radula, as I have observed in several species; so that the importance of variations from the counts of teeth given in the text must not be overestimated. Except in the case of *A. chiricahuana*, all of my preparations of genitalia, jaws and radulae are from specimens of the type lots.

From the data now in hand, it seems in a high degree likely that the ancestral stock of all known *Ashmunellas* had a tridentate aperture. There was a tendency to split the basal tooth, perhaps not expressed in the original stock, but subsequently developed orthogenetically in most of the subgroups. This tendency culminates in the *levettei* group, where the original basal tooth has been divided into two distinct and often widely separated teeth. There has also been degeneration of the aperture-teeth, parallel in various stocks, and culminating in several toothless forms, astonishingly alike, though of undoubtedly diverse parentage. *A. hyporhyssa* Ckll., *robusta* Pils., *chiricahuana* Dall, *esuritor* Pils., etc., are convergent forms of this character. The true relationships of such simplified species must be demonstrated by their internal anatomy. The idea that the toothless forms are primitive can hardly be entertained in view of their anatomical diversity and their demonstrable relation to several groups of toothed species, the evidently homologous teeth of which, on this hypothesis, would have been independently evolved. This would be homoplasy on too extensive a scale to be readily believed.

The aperture-teeth in *Ashmunella* curiously imitate those of *Polygyra*, a genus not in the least related. In Europe, *Isognomostoma* and *Helicodonta* have evolved similar forms in still other phyla.

There has been a tendency to overload *Ashmunella* with subspecific names, which would logically end in naming every colony in existence. I do not minimize the importance of noting and recording local differentiation. My appreciation of its omnipresence convinces me that it cannot all be stereotyped in nomenclature, and if it were, the result would be too unwieldy for any human intellect to make use of.

The range of individual variation in *Ashmunella* among specimens from one place is (with the exception of *A. l. heterodonta*) not greater than in *Polygyra*. Among specimens I have measured or examined, I have seen no lot which would yield a markedly bimodal curve were the variations plotted. The variations between different colonies or *gens* are often appreciable, sometimes conspicuous; but here also the case may readily be paralleled in *Polygyra*, although usually not in such restricted areas, for the reason that in the *Polygyra* country the topographic and climatic features are less emphatic, and the life-zones are not crowded upon one another as in the land of the *Ashmunellas*, but are spread over larger areas.

The conception of *species* in such sedentary animals as snails is far from simple. A "species" comprises a multitude of colonies or communities which at any one time are isolated one from the other by the existing topographic and other surface features of the country. This is and always has been the case, even with the common, widespread forms of the more level parts of the country; but the colonies there have always been subject to frequent mixture with their neighboring colonies, by the ever slightly fluctuating conditions of woodland and local moisture, so that their network over the country has been here and there made practically complete within comparatively short periods. As a consequence, we have in many cases no tangible difference between individuals from colonies hundreds of miles apart.

In regions where the local physical features are more accentuated, the colonies or communities are often less subject to mixture. Moreover, the range of conditions within a limited area is far greater. Thus snails of the same original stock living in the rocky talus on opposite sides of a canyon are often subject to very diverse conditions of heat, moisture and consequently cryptogamic food. They are often wholly unable to cross from one side to the other by reason of a wide, freshet-swept or arid space. Moreover, subsequent changes, such as the formation of lateral canyons and the localization of suitable stations in the talus, tend to further isolate the several colonies, and to preserve their individuality for long periods.

Thus each colony follows its own bent; and differentiation ensues, either by the cumulation of organic changes induced by varying conditions of growth and nutrition, determined by the local environment as mentioned above, or by the occurrence of diverse "mutations" in the several colonies, or by both causes. My idea of the practical isolation of snail colonies is based upon the experience of many years. Similar views have been expressed by Hemphill, in the

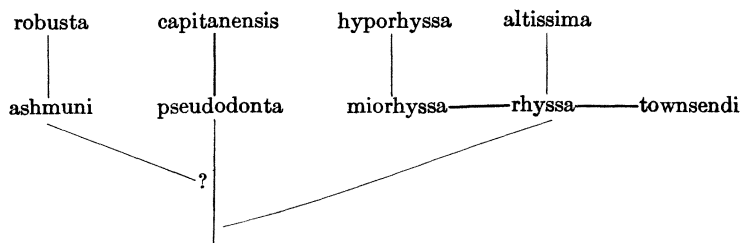
account of his collecting in Utah, and by Ferriss, who in speaking of the Huachucas says, "Every colony in the canyon was liable to have some distinctive mark in size, color or form. . . . No two colonies seemed exactly alike, and they did not visit back and forth, nor travel far from the best part of their own rock pile" (*Nautilus*, XVIII, p. 51).

When through some means two slightly differentiated colonies intermingle, as they occasionally must, hybridism follows, and a complex progeny issues, such as I have found in the Floridian *Liguus*. Who can unravel the tangled threads of affinity when the modified forms of two or more canyons reach each other across a divide! It is as complex as a modern human community, where subraces are mingling blood after centuries of pure breeding.

Group of A. rhyssa.

In species of this group, small basal and parietal teeth are often present, but there is no outer lip tooth. *The spermatheca and its duct are about half the length of the penis, epiphallus and flagellum, or even less.* The combined length of the penis, epiphallus and flagellum is decidedly less than three times the diameter of the shell. The penis is comparatively well developed.

This group is especially characteristic of the Capitan, White and Sacramento ranges of southern-central New Mexico, east of the Rio Grande. The forms now known arrange themselves in three series, thus:



The central and right-hand groups are known to be related by the genitalia. The group on the left is separated from these geographically, and its relationships must remain wholly uncertain until the soft parts can be examined.

Ashmunella rhyssa (Dall). Pl. XII, figs. 1-4.

Polygyra rhyssa Dall, *Nautilus*, XI, May, 1897, p. 2.

Ashmunella rhyssa Dall, Pils. and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 192; Dall, Proc. U. S. N. Mus., XXIV, p. 500, Pl. 27, figs. 11, 14.

This is the senior name for a member of the group of closely related forms inhabiting the Sierra Blanca and adjoining Sacramento Mountains, in middle-southern New Mexico.

The shell is more globose than any other known *Ashmunella*, having about the proportions of the large Eastern Mesodons. It is dull and roughly sculptured on the last whorl with *coarse, curved irregular wrinkles*, between and over which fine incised spirals may be traced. The rather small aperture is contracted by a wide, heavy lip, the outer margin of which is indistinctly thickened within. There is a low, indistinct basal tooth or callous, and a very small, deeply placed, oblique parietal tooth, sometimes absent. The umbilicus is narrow and deep, but slightly enlarging at the last whorl. Whorls $5\frac{1}{2}$.

Alt. 10, diam. 17 mm.

" 9, " 17 " (Dall's type).

" 10.2, " 16 "

" 10.2, " 16 "

" 9.9, " 15.5 "

" 9.3, " 15 "

" 8, " 14.9 "

Sierra Blanca, New Mexico, collected by Rev. E. H. Ashmun.

Ashmunella rhyssa miorhyssa (Dall). Pl. XII, figs. 5, 6.

Polygyra miorhyssa Dall, Nautilus, XII, p. 75, November, 1898.

Ashmunella rhyssa miorhyssa (Dall), Pils and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 193, figs. 1-3 on p. 189 (genitalia, jaw and teeth); Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 108 (anatomy).

This form differs from *A. rhyssa* chiefly in being smoother, the coarse wrinkles of that being reduced to striæ. The umbilicus is a little more open at the last whorl. In other respects there are no constant or even prevalent differences.

Alt. 9, diam. 16 mm. Sierra Blanca (Ashmun).

Alt. 9, diam. 15.5 mm. Sierra Blanca (Ashmun).

Alt. 10.6, diam. 16.8 mm., whorls 6

Alt. 9.9, diam. 16 mm., whorls $5\frac{1}{2}$.

Alt. 10.3, diam. 16 mm., whorls $5\frac{3}{4}$.

} Near Eagle creek, Sierra
Blanca (Townsend).

Sierra Blanca, Lincoln county, New Mexico (E. H. Ashmun).
Near Eagle creek (C. H. T. Townsend).

Ashmunella rhyssa hyporhyssa (Ckll.). Pl. XII, figs. 7-13.

Polygyra r. hyporhyssa Ckll., Nautilus, XII, November, 1898, p. 77.

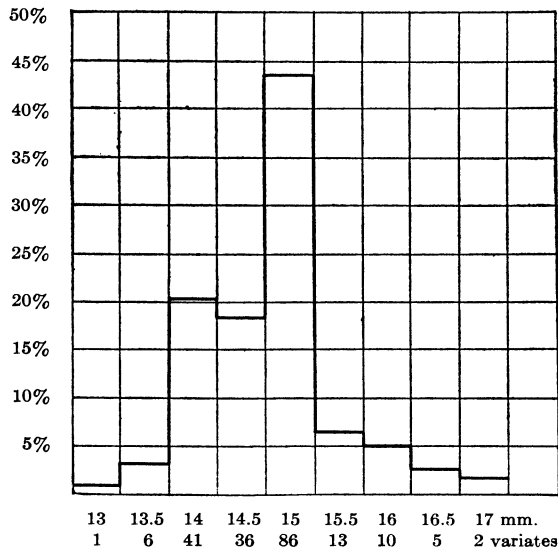
Ashmunella hyporhyssa (Ckll.) var. *edentata*, with mut. *rufescens* and *alba*, Ckll., Nautilus, XIV, p. 72, October, 1900 (Cloudercroft).

A. r. hyporhyssa Ckll., Vanatta, Nautilus, XVI, p. 58, September, 1902 (Highrolls and Cloudercroft); Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 108, fig. 1 (genitalia of Cloudercroft specimen).

"Like *rhyssa* in size and form, but umbilicus wider, exposing the penultimate whorl; sculpture finer, consisting of striæ rather than riblets. One specimen, diam. max. 15, min. $12\frac{2}{3}$, alt. 9 mm."

Lower slopes of Sierra Blanca, New Mexico, above head of Ruidoso creek, in aspen belt, about 9,500 feet altitude. (Prof. C. H. T. Townsend, August 14, 1898.)

The original description is given above. The unique type specimen was lost. Prof. Cockerell subsequently described what seems to be the same race, or one excessively similar, as *A. hyporhyssa edentata*, with mutations *rufescens* and *alba*, from Clouderoft, Sacramento Mountains. In the absence of any differential feature in the description or measure-



ments, I assume that the Clouderoft shells are identical with *hyporhyssa*.

A somewhat large series was collected by Mr. H. L. Viereck in James Canyon, at Clouderoft, Sacramento Mountains, at an elevation of 9,500 feet. Two lots were taken, one of a few large specimens (Pl. XII, figs. 7, 8), the other of many smaller ones. Compared with *A. rhyssa* the shells differ in the constantly *more depressed last whorl*, though the spire may be equally high; the umbilicus is wider at its opening, exposing more of the penultimate whorl; the basal tooth is obsolete or very weak, and the parietal tooth is present only as an extremely small vestige in less than 5 per cent. of the specimens. Finally, the

sculpture is less strong except just behind the lip, where the wrinkles generally are emphatic.

The lot of smaller specimens (Pl. XII, figs. 9-13) consisted of about 300 shells. 200 fully adult specimens were measured. The diameter varies between 13 and 17 mm., and gives the curve plotted on p. 229. The major mode is at 15 mm., 43 per cent. of the lot being within .2 mm. of that dimension. There is a minor mode at 14 mm.; but the lot is remarkably homogeneous, since over 80 per cent. are between 13.8 and 15.2 mm. diameter.

The altitude bears no constant ratio to the diameter. It is individually variable within wide limits. In the first 50 *individuals of 15 mm. diameter* (from my schedule of measurements of 200 specimens of all sizes) the following dimensions were found:

Alt. in mm.,	8	8.5	8.6	8.7	8.8	8.9	9	9.2
No. of variates,	3	2	3	3	5	3	15	2
Alt. in mm.,	9.3	9.4	9.5	9.6	9.7	9.8	10	10.2
No. of variates,	3	1	2	1	2	2	1	1
Alt. in mm.,	10.6							
No. of variates,	1							

It will be noticed that the mode is at 9 mm., 30% of the whole number having that altitude, while the number of more depressed individuals is as nearly as possible equal to the number more elevated. Specimens of the same lot, of other diameters, give altitude curves of the same symmetrical form, and need not here be detailed.

There are 5 albinos in the 200 shells measured, though an uninterrupted series from albinos to the darkest brown specimens makes a selection difficult.

Nine shells in 200 show a very small parietal tooth, one being shown in fig. 12.

The other lot, of larger shells (Pl. 12, figs. 7, 8), contains 2 albinos out of 14 shells. None has a parietal tooth. The measurements follow:

Alt.,	12	11	10	10.3	10.7	10	10	10	10
Diam.,	19.3	19	19	18.5	18.3	18.3	18.2	18	17.5
Alt.,	10	10	9.2	9.2 mm.					
Diam.,	17.5	17	17	16.8	"				

A small series from Cloudercroft, 8,750 feet, collected by E. O. Wooton, received from Prof. Cockerell, contains also large and small examples,

the diameters being, large, 18.5, 18, 17.3, 17, 16.2, and small, 15, 15 mm. These are part of Prof. Cockerell's original lot of *A. h. edentata*.

At Highrolls, in the Sacramento Mountains, at 6,500 feet elevation, Mr. Viereck obtained three specimens, 17.2, 17 and 16.8 mm. diam. They have the umbilicus a trifle narrower than in the larger Cloudercroft shells.

In Alamo Canyon, 14 miles from Alamogorda, Mr. Ferriss picked up a few dead specimens. The umbilicus is decidedly narrower than in the Cloudercroft shells. One of five examined has a vestigial parietal tooth. The proportions of alt. to diam. are as in Cloudercroft shells. Diam. 16.2, 16, 15.8, 13.7 mm.

***Ashmunella rhyssa townsendi* (Bartsch).**

Ashmunella townsendi Bartsch, Smiths. Misc. Coll., XXXXVII, p. 13, August 6, 1904.

Described from two specimens. "Most nearly related to *A. rhyssa* Dall, but is much smaller than that form, and is uniformly more strongly sculptured."

Alt. 8.2, diam. 15 mm.

Sierra Blanca, on the slopes of the ridge on the south fork of Ruidoso river, about 5 miles above the town of Ruidoso, Lincoln county, New Mexico, at an altitude of 8,500 feet. C. H. T. Townsend.

A. rhyssa commonly varies from less than 15 to 17 mm. in diameter, and from 8 to over 10 mm. alt., so that the present form falls within its range of size. The coarser sculpture of "many strong sublamellar axial ribs" seems to be its chief or only distinguishing character. It stands, apparently, between *rhyssa* and *altissima*.

***Ashmunella altissima* (Ckll.).** Pl. XII, fig. 14.

Polygyra altissima Ckll., Nautilus, XII, p. 76, November, 1898.

Ashmunella altissima (Ckll.), Pils. and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 192.

The shell is small and depressed, of $5\frac{1}{4}$ moderately convex whorls, the inner ones enlarging slowly, the last much wider, with the periphery above the middle, very obtusely subangular in front, elsewhere well rounded. The only specimens yet found are dead, bleached and somewhat worn, having lost all of the cuticle. The embryonic $1\frac{1}{2}$ whorls are smooth; the first neanic whorl almost equally so. Then oblique striæ set in which gradually become coarser. On the last whorl they become strong, *rounded sigmoid ribs, very strong on the last half whorl*. There are traces of fine spiral lines between the ribs. Behind the lip the whorl is moderately contracted, and it descends a trifle to the aperture. The aperture is very oblique, lunate. The peristome is thickened within and on its convex face, narrowly reflexed throughout.

There is a faint, hardly noticeable basal prominence, but nothing to be called a tooth. There is no parietal tooth, and the callous between the lip-ends is very thin.

Alt. 5.5, diam. 11 mm.

Sierra Blanca, on the highest summit, three found under a rock, elevation 11,092 feet (C. H. T. Townsend).

One of the co-types of this very distinct form is figured, No. 73,558, A. N. S. P.

Ashmunella pseudodonta (Dall). Pl. XII, figs. 15, 16, 17, 18.

Polygyra pseudodonta Dall, Proc. U. S. Nat. Mus., XIX, 1896, p. 343 (White Oaks, New Mexico).

Ashmunella pseudodonta Dall, Proc. U. S. Nat. Mus., XXIV, 1902, p. 500, Pl. 27, figs. 13, 15; Pl. 28, figs. 7.

Ashmunella pseudodonta Pils. and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 192; Murdoch, Jour. of Malac., VIII, p. 79, Pl. 7, figs. 1-7 (anatomy).

This species differs from those of the Sierra Blanca chiefly by its more depressed shape and the bifid basal callous, which is split into two low denticles like some of the subspecies of *A. thomsoniana*. The comparatively short duct of the spermatheca shows *A. pseudodonta* to be much more closely related to *A. rhyssa* than to *A. thomsoniana*. Five specimens of the original lot collected by Mr. Ashmun at White Oaks, New Mexico, measure:

Alt.,	7	7	6.5	6.4	6.4 mm.
Diam.,	13	12.7	12.7	12.2	12 "

Two specimens found with *A. p. capitanensis* measure:

Alt. 7 6.7 mm.

Diam., 13.9 13.5 "

The internal anatomy has been well described and figured by Murdoch.

Ashmunella pseudodonta capitanensis Ashm. and Ckll. Pl. XII, figs. 21-23.

A. p. capitanensis Ashmun and Cockerell, Nautilus, XII, p. 131, March, 1899.

The shell is depressed, glossy, brown, with weak irregular growth-wrinkles and fine, close incised spirals. The spire is very low conic. Whorls $5\frac{1}{2}$, quite convex, the last wide, rounded peripherally, swollen above behind the deep constriction behind the lip. The aperture is quite oblique, the lip either brown-tinted throughout or white. Within the basal margin there is a *low, very weakly bifid callous, often hardly noticeable*. There is a very small parietal tooth in four out of six specimens examined. The umbilicus is small and deep within, enlarging at the last whorl, *rather broadly exposing the penultimate whorl*.

Alt.,	9	9.5	9.2	9	9	9 mm.
Diam.,	18.5	18	17.8	17	17	17 "

Near Baldonado Springs, Capitan Mountains, Lincoln county, New Mexico, elevation 8,200 feet, collected by E. H. Ashmun.

This form is at present well separated from *pseudodonta* by the uniformly much larger size. The basal teeth are also less developed, and the lip comparatively narrower. It is to *pseudodonta* as *robusta* is to *ashmuni*. It has reached about the same stage of evolution as *A. hyporhyssa*, *A. a. robusta* and *A. chiricahuana*. In the lot of 100 specimens taken by Mr. Ashmun there is one pale greenish-corneous albino.

Ashmunella ashmuni (Dall). Pl. XII, figs. 19, 20.

Polygyra ashmuni Dall, Proc. U. S. Nat. Mus., XIX, p. 342, 1896.

Ashmunella ashmuni (Dall) Pils. and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 192; Ancey, Jour. of Malac., VIII, p. 76; Dall, Proc. U. S. Nat. Mus., XXIV, p. 501, Pl. 28, figs. 4, 6, 9.

This species is small, much like *A. pseudodonta*, but there is scarcely the trace of a basal tooth. The outer lip is well thickened within, and there is no parietal tooth. The usual wrinkle-like growth-lines are present, but spiral lines are very faint, not discernible in some specimens. Five of the original lot measure:

Alt.,	7.4	7	7	6.9	6.7 mm.
Diam.,	14.2	14	14	13.1	12.7 "

Bland, New Mexico. E. H. Ashmun.

Ashmunella ashmuni robusta n. subsp. Pl. XII, figs. 24-26.

Polygyra chiricahuana and *Ashmunella chiricahuana*, in part, of various authors, specimens from Jemez Mountains and at Jemez Sulphur Springs, New Mexico.

The shell is similar in size and general contour to *A. p. capitanensis*; chestnut or greenish-chestnut colored, glossy, sculptured with low, irregular growth-wrinkles which are strongest below the suture, and weaker on the base, and very fine incised spirals, close and numerous but very lightly impressed. The spire is very low conoid. Whorls $5\frac{1}{2}$, convex, the last about double the width of the preceding, its last third decidedly swollen, inflated behind the deep constriction back of the lip. The aperture is roundly lunate, without teeth. The lip is coffee-tinted, rather narrowly reflexed, convex on the face, and a little thickened inwardly within the outer margin. There is no parietal tooth. The umbilicus is cylindric within and deep, rather broadly expanding at the last whorl, exposing the penultimate whorl.

Alt.,	9.2	8.6	8.7	9 mm.
Diam.,	19	17.2	17.6	16.5 "

Jemez Mountains, near Bland, New Mexico, at higher elevations than *A. ashmuni*. E. H. Ashmun.

This form has hitherto been referred to *A. chiricahuana*, from which it differs chiefly in the greater *inflation of the latter part of the last whorl*. This is noticeable in a side view, and is seen prominently above the aperture in a front view. It differs from *A. pseudodonta capitaneensis* chiefly by wanting basal teeth.

In such simplified forms as this, it is not easy to determine the true relationships by the shell alone. When the genitalia can be examined the affinities of *A. ashmuni* and *A. a. robusta* will doubtless become clear. There is an albino in Mr. Ashmun's collection.

Group of A. thomsoniana.

Aperture of the shell with parietal, outer and basal teeth, the latter often bifid, divided into two contiguous tubercles. Length of the spermatheca and its duct 60 to 65 per cent. that of the penis, epiphallus and flagellum in known forms.

These forms are from northern central New Mexico. They have been investigated chiefly by Prof. T. D. A. Cockerell and his pupils.

By their genitalia and shells they are related to the southeastern Arizona group. Three forms are perhaps sufficiently differentiated to require names: *A. t. porterae*, *A. thomsoniana* and *A. t. pecosensis*.

Ashmunella thomsoniana (Ancey). Pl. XIII, figs. 27-30.

Helix levettei Bland var. *thomsoniana*, and var. *orobæna* Ancey, Conchologist's Exchange, II, p. 64 (November, 1887).

Ashmunella thomsoniana (Anc.) Pils. and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 192; Ancey, Jour. of Malac., VIII, p. 75, 1901; Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 108, fig. 2 (genitalia of specimen from Santa Fé canyon); Ckll. and Cooper, Nautilus, XV, p. 109, February, 1902, with mut. *alba* C. and C., *l. c.*, p. 110 (Canyon Diablo); Ckll., Nautilus, XVI, January, 1903, p. 105 (Pecos Pueblo).

Ashmunella thomsoniana cooperæ Cockerell, Nautilus, XV, p. 35, July, 1901.

A. t. antiqua Ckll. and Coop., Science, December 27, 1901, p. 1,009; Nautilus, XV, p. 110 (Pleistocene, Las Vegas).

Specimens from J. H. Thomson, part of the original lot from Santa Fé Canyon, are before me, and two are illustrated (Pl. XIII, figs 27, 28).

It is narrowly umbilicate, brown and glossy, finely striate, with very faint traces of incised spirals on the last whorl. There are 5 whorls. The characters of the aperture are sufficiently shown by the figures, the only ones published to this time. The basal tooth is simple in all specimens I have seen from the type canyon.

Alt. 6.9, diam. 13 mm.; whorls 5.

" 6.9, " 12.2 " " 5 $\frac{1}{2}$.

" 6.9, " 13.1 " " 5 $\frac{1}{2}$.

The specimen I dissected in 1900, collected by Prof. Cockerell at

Monument Rock, Santa Fé Canyon, at 8,000 feet above the sea (Pl. 13, fig. 29), is slightly larger with the *umbilicus* wider at the opening. Alt. 7.2, diam. 14 mm.; whorls $5\frac{3}{4}$. The basal tooth is simple. Another like it, taken by Ashmun in the same canyon, is figured (Pl. 13, fig. 30).

In all the forms referred to *A. thomsoniana* and its subspecies no distinct internal lip-rib is formed when a resting-stage occurred in the neanic period. Such growth-arrests are often indicated by a darker streak on the penultimate or beginning of the last whorl, but the shell is very rarely thickened within by a white callous, and when present, the callous is very thin.

Distribution: Santa Fé Canyon (Thomson, Ashmun, Ckll.); Las Vegas and Las Vegas Hot Springs (Miss Cooper, Prof. Ckll.); Canyon Diablo, near Rowe (Mary Cooper); Old Pecos Pueblo, near Vallé ranch, Pecos (W. C. Ckll.).

The form from Las Vegas Hot Springs, at about 7,000 feet elevation, called *A. t. cooperæ*, offers no tangible difference from Santa Fé *thomsoniana*. It is not yet evolved enough to be distinguishable from *thomsoniana* if the specimens were mixed. I do not think it desirable or practicable to name forms so very slightly differentiated. The umbilicus is a trifle more open than typical *A. thomsoniana*, like the Monument Rock shells or a little less open, being thus intermediate in size. The teeth are in the average *slightly smaller*. The basal tooth is quite feebly doubled in a minority of the shells seen, simple, small and tubercular in the others. The spire is, in the average, a trifle higher than in Santa Fé *thomsoniana* (Pl. XIII, figs. 31-34, the last a co-type of *A. t. cooperæ*).

	<i>Co-types of cooperæ.</i>								
Alt.	8	7.9	7.3	7.9	7	7	7.3	7.1	6.8 mm.
Diam.	13	13	13.8	13.8	13.5	13.5	13.3	13	12.2 "
Whorls	5+	5+	5+	$5\frac{1}{2}$	$5\frac{1}{2}$	5	$5\frac{1}{2}$	5	$4\frac{3}{4}$

A. antiqua Ckll. and Coop., from the Pleistocene at Las Vegas, New Mexico, is like the shells from Las Vegas Hot Springs noted above in size, but the basal tooth is a low, wide callous, slightly emarginate but not distinctly bifid. The rather heavy teeth and small umbilicus are like typical *thomsoniana*. A co-type measures 13.2 mm. diam. The parietal callous has scaled off, carrying the tooth with it. I see no valid reason for believing that it represents a divergent branch of *thomsoniana*. Such characters as this are merely individual.

Specimens from Canyon Diablo, near Rowe, New Mexico (Pl. XIII, figs. 35, 36, 37), are exactly like those from Las Vegas Hot Springs.

Alt.	8	6.8	6.6	6.4	6.3 mm.
Diam.	14	12.8	12.3	12.3	12 “
Whorls	5½	5½	5½	5½	5 “

Ashmunella thomsoniana porterae Pils. and Ckll. Pl. XIII, figs. 39-46.

Ashmunella thomsoniana porterae Pils. and Ckll., Nautilus, XIII, p. 49, September, 1899; Cockerell and Cooper, Nautilus, XV, p. 109, February, 1902, with mut. *alba*, p. 110; Murdoch, Jour. of Malac., VIII, p. 82, Pl. 7, fig. 8 (genitalia); Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 559, footnote 4, Pl. 21, fig. 6 (pallial complex).

A. t. cooperæ Ckll., Nautilus, XVII, p. 36, July, 1903 (Pecos).

Shell larger than *thomsoniana*, light brown, glossy, a little translucent, with distinct growth-wrinkles and fine incised spiral lines. Whorls 5½ to 6, convex, the last deeply constricted behind the lip, swollen behind the constriction. Lip brown-tinted above. Parietal lamina moderately developed. Outer lip-tooth long and concave. *Basal tooth bifid*, the inner denticle smaller, sometimes reduced to a low callous. Umbilicus rather broadly open, exposing the penultimate whorl more than in *thomsoniana*.

Type locality, Upper Sapello Canyon, Beulah, New Mexico (Pl. XIII, figs. 39-42, 46, Miss Wilmatte Porter, Dr. H. Skinner and others).

Twenty-two specimens collected by Dr. Skinner measure as follows:

Alt.	8	8.5	8	8.5	8	8	8	8	8.2
Diam.	17	15.3	15.8	15.3	15.3	15	15.6	14.8	15
Whorls	6	5½	5¾	5½	5½	5½	5½	5½	5½
Alt.	8.2	8	8.5	8.8	7.8	8	7.7	8	7.8
Diam.	15.5	15	15	15.5	13.8	14	14.8	14	14
Whorls	5½	5½	5½	5¾	5½	5½	5½	5½	5½
Alt.	7.8	8	8	7.6 mm.					
Diam.	14.1	14	14.1	13.9	“				
Whorls	5½	5½	5½	5½					

Prof. Cockerell and Miss Cooper measured 40 specimens of *porterae* from Beulah:

2 specimens are	14	mm. diam.
12 “	“ 14+	“ “
17 “	“ 15	“ “
6 “	“ 15+	“ “
3 “	“ 16	“ “

There is no appreciable difference in the comparative altitude among the specimens I have seen.

Miss Mary Cooper collected specimens in Manzanares Valley, near Rowe, New Mexico, which have been reported on by Prof. Cockerell and Miss Cooper (*Nautilus*, XV, p. 109). They are in all respects like those of the type locality except that the inner basal denticle is more obsolete, as in fig. 39. The curve of diameters is the same as in the Beulah lot. The specimens I have seen are from 15 to 16 mm. diam.

A single specimen I have seen from Cooper's Mill, near Rowe, New Mexico, measures 8.7 x 16 mm., with $5\frac{1}{4}$ whorls. The inner basal denticle is low, as in Manzanares shells.

The shells from Pecos, New Mexico (Pl. XIII, figs. 43-45, collected by Cockerell), are intermediate between *thomsoniana* and *porterae*; the size being that of the former, while in 14 out of 17 specimens before me the basal tooth is double, as in *porterae*. In the others it is simple, as in *thomsoniana*. The umbilicus is rather wide, as in *porterae*. Prof. Cockerell refers the form to *A. t. cooperæ*. Its location depends upon whether size is more important than the teeth as an index of affinity; but the question of name is of minor importance in view of the intergradation of the whole series. Specimens measure:

Alt.	8.2	8.2	8	8.2	8	8	7.7	7.9
Diam.	15	14.7	14.6	14.5	14.3	14.3	14.3	14
Whorls	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{3}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{3}$	$5\frac{1}{2}$
Alt.	7.8	7.8	7.6	7.5	7.6	7.3	7.2	7
Diam.	14	14	14	13.8	13.5	13.5	13.2	13.2
Whorls	$5\frac{1}{2}$	$5\frac{1}{3}$	$5\frac{1}{3}$	$5\frac{1}{3}$	$5\frac{1}{4}$	$5\frac{1}{3}$	$5\frac{1}{4}$	$5\frac{1}{3}$

There is practically no variation in number of whorls, or in the proportion of altitude to diameter. The variation in diameter is not great, but serves to connect *thomsoniana* and *porterae*, but the skew of the curve is toward the larger size of *porterae*.

Ashmunella thomsoniana pecosensis Ckll. Pl. XIII, fig. 38.

Cockerell, *Nautilus*, XVI, p. 105, January, 1903.

Shell like *thomsoniana* in shape, size, the small umbilicus and the simple basal tooth; but differing in sculpture, a coarse, low costation being superposed upon minute growth-lines and microscopic spirals similar to those of *A. thomsoniana*. Aperture as in *thomsoniana*, the "lip and teeth strongly developed, the basal tooth single."

Alt. about 6.3, diam. 11.8 mm.

Vallé ranch, Pecos, New Mexico. A Pleistocene fossil. Type No. 84,209, A. N. S. P., collected by T. D. A. Cockerell.

Some specimens of *A. thomsoniana* from Las Vegas Hot Springs are almost as strongly wrinkled or costulate. The subspecies cannot, therefore, be considered to be strongly differentiated.

Group of A. levettei.

The aperture has four teeth, but sometimes the two basal teeth are contiguous, partially united. The length of the spermatheca and its duct is from 55 to 73 per cent. of that of the penis, epiphallus and flagellum in known forms.

This somewhat heterogeneous group is characteristic of southwestern New Mexico and southeastern Arizona. Here are grouped about ten species and subspecies, some of them exceedingly specialized.

Ashmunella levettei (Bld.). Pl. XV, figs. 72-78.

Triodopsis levettei Bland, Annals of the New York Academy of Sciences, II, 1882, p. 115 (cuts); Binney, Manual of American Land Shells, p. 385; Supplement to Terrestrial Mollusks, Vol. V, p. 154, Pl. 1, fig. E, copy from Bland; Second Supplement, in Bull. Mus. Comp. Zool., XIII, No. 2, p. 36, Pl. 1, fig. 15, December, 1886.

Polygyra levettei Bld., Dall, Proc. U. S. Nat. Mus., XIX, p. 341, 1896.

Ashmunella levettei Bld., Ancey, Journ. of Malac., VIII, p. 74, September, 1901.

This is a form of ample proportions, rich dark chestnut color and glossy surface. The periphery is rounded, or has a mere trace of angulation in front. The cylindric umbilicus enlarges rapidly at the last whorl. The spire, while compactly convoluted, has more rapidly widening whorls than *A. l. angigyra*. The spaces between the three lip-teeth are about equal. The parietal lamella has a "kink" or inward bend at the axial end in the type specimen, but this kink is often wanting; being a variable character in *levettei* and allied species. There are about $6\frac{1}{2}$ whorls, all convex. The first $1\frac{1}{2}$ are smooth and glossy except for short striae radiating from the suture; on the second whorl these striae extend across the whorl. The following whorls are very finely, irregularly marked with faint growth-lines. On the penultimate and last whorls there is a faint, excessively fine and close spiral striation, too minute to be visible except with a compound microscope; and a fine malleation in spiral direction, or spiral impressed lines, readily seen with the hand lens or even the naked eye. The periphery is rounded. Bland's type measured, alt. 6.5, diam. 16 mm.; aperture, including peristome, 7×8 mm., according to the original description. Bland evidently measured the altitude of the axis, not of the whole shell to the base of the lip. His type, which I have examined, agrees with the shells Mr. Ferriss found in Bear and Miller Canyons, in the Huachuclas. Figs. 72-75 represent shells from Bear Canyon, agreeing with type specimen in all respects.

Huachuca Mountains, Cochise county, Arizona, in Bear, Miller and Carr Canyons (James H. Ferriss). It has been reported also from near Tucson, Arizona (Cox). I have seen no specimens from that place.

Bland originally described *levettei* as from Santa Fé Canyon, New Mexico, but the researches there of Ashmun, Cockerell and others have failed to bring it to light. Indeed, no closely related species is known to occur within hundreds of miles of that place, whereas some of the Huachuca shells agree perfectly with the type specimen of *levettei* which I have examined. There can be little doubt that Dr. Levette was mistaken in the locality. It is not known that he collected the shells himself. They may have been given him by some army officer who had served in the Southwest. There is, according to Mr. C. R. Biedermann, a Santa Fé Canyon in the San José mountains, just south of the Huachuca range, in Mexico.

A series from Bear Canyon measures:

Alt. 9,	diam. 17.8 mm.;	width aperture	outside 8	mm.
" 9,	" 17.2	" "	" 8	"
" 8.2,	" 17	" "	" 8	"
" 7.8,	" 16.7	" "	" 8	"
" 7.2,	" 16	" "	" 7.2	"
" 7.8,	" 16.2	" "	" 8	"

The lip is either brown or nearly white. Mr. Ferriss' largest specimen from Bear Canyon measures 8 x 18 mm.

Fig. 76 represents a beautiful albino found at the head of Bear Canyon, on the southwest side of the Huachuca range, at about 7,000 feet elevation. It is bluish white under a very thin caducious pale yellowish cuticle.

A pathologic specimen from the same place (fig. 77) has suffered extensive breakage at the aperture. A new peristome has been formed and three of the teeth regenerated, typical in shape and position. The inner basal tooth, however, is only feebly represented by a low callous.

The shells from Miller Canyon, on the north side of the Huachuca (Pl. XIII, fig. 78), are intermediate between the Bear Canyon *levettei* and the slightly different race from Carr Canyon, perhaps nearer the latter. They measure from alt. 8.5, diam. 16.3, aperture 7.8 mm. to alt. 7.5, diam. 14, aperture 6.3 mm.

In Carr Canyon, about four miles farther eastward, at about 5,000 feet elevation, a form was found resembling *angiggyra* in its close-coiled whorls and small aperture, but differing in being usually larger, hardly angular, with a larger umbilicus and deeper constriction back of the

lip. It differs from *levettei* in the smaller mouth, larger umbilicus and deeper constriction. Specimens measure:

Alt. 7, diam. 15.2 mm.; width of mouth, outside, 7.3 mm.

"	7.2,	"	15.2	"	"	"	7	"
"	7.2,	"	15.2	"	"	"	7	"
"	7,	"	15	"	"	"	7	"
"	6.3,	"	14	"	"	"	6.1	"
"	6.8,	"	13.8	"	"	"	6	"
"	6.8,	"	14	"	"	"	6.7	"
"	6.3,	"	12.5	"	"	"	5.8	"

This form is about intermediate between *levettei* and *angigyra*, but it has some slight special characters of its own. They seem hardly sufficient to require that it be named. See Pl. XV, figs. 92, 93.

Ashmunella levettei angigyra n. subsp. Pl. XIV, figs. 47-54.

The shell is brown, smaller and more depressed than *levettei* obtusely but distinctly *angular* at the periphery. The surface of the post-embryonic whorls is smoothish, under the lens seen to be very closely, irregularly marked with minute growth-lines, giving it a silky luster, and the last whorl is often finely malleate spirally, as in *A. levettei*. Whorls $6\frac{1}{4}$ to 7, very closely coiled and slowly widening, *all of them convex* above. The suture descends rather abruptly to the aperture. Behind the outer and basal lips the whorl is rather deeply, angularly guttered. The back of the lip is creamy. Aperture very oblique, smaller than in *A. levettei*. The teeth are arranged as in *levettei*. The notch between the two basal teeth is wider than that between the outer basal and the tooth of the outer lip. The inner basal tooth is smaller than the outer. The cylindric umbilicus rapidly enlarges at the last whorl.

Alt. 6.5, diam. 13.6 mm.

"	6.3,	"	13.2	"
"	6,	"	13	"

Huachuca Mountains, in Ramsey or "Conservatory" Canyon, near Fort Huachuca. Types No. 83,269, A. N. S. P., collected by J. H. Ferriss, 1902 (figs. 47-49).

This form was also found in the drift-débris of Barbakomari creek, near Huachuca station. The same form was collected by Mr. Mearns some years ago, and then referred to *levettei*.

It differs from typical *A. levettei* in being smaller, with more closely coiled whorls, the last one angular at the periphery. The aperture is smaller and therefore more filled by the teeth. It resembles *A. angu-*

lata, but the whorls are not flattened above as in that species, and are not punctate.

With a single exception mentioned below, no *angigyra* have been found on the south side of the range. On the north side it occurs in Brown's Canyon (figs. 50, 54), varying much in size and degree of angulation, the smaller specimens being like the type lot, the larger ones less angular and approaching *levettei*. Five measure:

Alt. 7.3, diam. 14.8 mm.

" 7, " 14.8 "

" 6.7, " 14.5 "

" 7, " 13.8 "

" 6, " 12 "

At Ramsey Canyon, two miles east of Brown's Canyon, similar forms were found at about 6,000 feet elevation.

On the opposite side of the range, at the base of Bear Canyon, in the foothills, at about 5,000 feet, Mr. Ferriss collected a few small specimens which do not seem to differ much from typical *angigyra*. Two before me measure 5 x 11 and 4.8 x 10 mm., with only 5½ whorls (figs. 51, 52, 53).

The genital system (Pl. XXI, fig. 28) is somewhat peculiar. The penis is quite long, but the vagina is unusually short. This is unlike *A. angulata* of the Chiricahuas, some forms of which imitate *angigyra* in the form of the shell.

The jaw (Pl. XXIII, fig. 14) has 8 very unequal ribs.

The radula (Pl. XXII, fig. 12) has 19.10.1.10.19 teeth. The ectocones of central and inner lateral teeth are very short. The mesocone is bifid from about the 15th tooth out, but the ectocone only on the outer marginals. This approximates to the condition found in *A. chiricahuana*. There are more teeth and more laterals than in *A. angulata*.

Ashmunella levettei heterodonta n. v. Pl. XV, figs. 80-91.

In Cave Creek Canyon and the tributary Ida Canyon on the southern slope of the east end of the Huachuca range, Mr. Ferriss found an extraordinary series of Ashmunellas, in which the teeth vary from about as well developed as in *A. levettei* to completely obsolete as in *A. chiricahuana*. No other member of the genus was found in these canyons. The several stages *occur together*,² and the chain of mutations is uninterrupted.

²See also Mr. Ferriss' notes on this race, *Nautilus*, XVIII, p. 51, below middle of page.

So far as I know, such variability in a land snail among individuals living under the same conditions in one spot is elsewhere absolutely unknown.

Most of the specimens measure from 15 to 18 mm. diam., but there is one pygmy of 12 mm. (fig. 88). In the general shape, etc., the race does not differ from *A. levettei*. There is no trace whatever of pathologic or abnormal growth. The forms with well developed teeth and those with none were found much less numerous than the intermediate stages. The most abundant forms (figs. 84, 85) may be considered the types of the variety.

The toothless examples have the lip slightly wider than that of *A. chiricahuana*. They constitute a race parallel to that, rather than identical with it.

The colonies of Cave and Ida Canyons are evidently undergoing rapid degeneration of the teeth, the parent form having been typical *A. levettei* such as occurs in the adjacent canyon westward, and that over the ridge. Examples of such degeneration are common enough at any stage of progress; but the unique feature about it in this particular colony is that the individuals have been so unequally affected that all stages of the process are present at one time and place. It does not seem to be a case of hybridism between *A. levettei* and *A. chiricahuana*, as I at one time suspected. The results are unlike hybrid colonies in the predominance of intermediate individuals.

Figs. 80 to 87 of Pl. XV are a series from Ida Canyon, showing stages of tooth development. Figs. 89, 90, 91 are from the Cave Creek Canyon series. All of these figures are photographed from fully mature shells.

Two specimens before me from Miller Canyon, or extreme head of Cave Creek Canyon, Huachucas, figured on Pl. XV, figs. 94, 95, may be toothless *heterodonta*, as Mr. Ferriss suggests to me; though from the narrower lip I had provisionally called them *A. chiricahuana*, to which they seem absolutely similar. If the latter be correct, these are the only specimens of that species I have seen from the Huachuca range. They measure 18.3 and 16 mm. in diameter. The smaller shell is an albino.

***Ashmunella levettei proxima* n. subsp.** Pl. XIV, figs. 65, 66, 70, 71.

The shell is depressed, biconvex, strongly angular at the periphery, *pale corneous-brown*. Whorls $6\frac{1}{2}$, none with punctate sculpture. Aperture like that of *A. angulata*, except that *the two basal teeth are nearer together, the space between them being smaller than that between the outer basal and the upper lip-tooth*; though the two basal teeth are not united basally as in *A. fissidens*.

Alt. 5.3, diam. 12 mm.

" 5.3, " 12.9 "

" 5.8, " 12.9 "

Chiricahua Mountains, Sawmill Canyon. Types No. 86,498, A. N. S. P., collected by James H. Ferriss.

Less carinated than the closely related *A. fissidens* which is apparently a member of the same series. It is difficult to decide on the rank to be given to the members of these chains of modifications of a single type. *A. proxima* will probably be considered a species eventually.

There are 14.10.1.10.14 teeth. The side cusps are very short, almost subobsolete on the central teeth. The tenth to twelfth teeth are transitional. Both cusps are split on the marginal teeth.

The genitalia (Pl. XXI, fig. 24) of one of the type specimens figured has the atrium protruded. There seems to be an extremely short basal enlargement or penis in another individual opened. The retractor muscle of the penis is very weak. The proportions of the organs are given in the table on p. 224. The very short penis contrasts with *A. l. angigyra*, which also has more marginal teeth.

The jaw (Pl. XXIII, fig. 17) is thin, with about 5 ribs, of which only two are well developed.

Ashmunella fissidens n. sp. Pl. XIV, figs. 67-69.

Shell depressed, lens-shaped, biconvex, with *acutely angular periphery*; rather thin, brown. Sculptured with fine, irregular growth-lines, the penultimate and next earlier whorls more or less roughened with minute elevated points, as in *A. angulata*. Spire very low conoid. Whorls fully 6, closely coiled, moderately convex, the last usually a little impressed above the periphery, which is angular throughout. It is convex below, and deeply guttered behind the reflexed outer and basal margins of the lip. The suture descends a little to the aperture. The aperture is very oblique, much obstructed by four teeth; an oblique parietal lamella, curved in at its axial end, with, in old specimens, a very low converging ridge outside of it, the two arranged V-like; a long, square-topped or concave-topped tooth within the outer lip; and *two contiguous teeth on the basal lip, slightly united basally* the outer one thick and higher, the inner low and more spreading. Parietal callous distinct.

Alt. 5.3, diam. 12.3 mm.

" 5, " 11.5 "

" 4.9, " 11.7 "

Chiricahua Mountains, in Cave Creek Canyon. Types No. 87,022, A. N. S. P., collected by James H. Ferriss, February, 1904.

This species differs from *A. angulata* by its contiguous basal teeth, but is related to it by the punctate surface. It resembles *A. duplicitens* in some respects, but the basal teeth are not nearly so closely united as in that snail, the periphery is carinate, not merely angular, and the whole shell is much more depressed.

Ashmunella duplicitens n. sp. Pl. XVI, figs. 103-107.

Shell depressed, umbilicate, brown or corneous-brown, glossy and sculptured with minute growth-lines only. The spire and base are convex, the periphery obtusely subangular in front, and situated above the middle of the last whorl. There are $5\frac{3}{4}$ to $6\frac{1}{2}$ closely coiled, narrow and moderately convex whorls, the last one very slightly descending in front. The aperture is ear-shaped, very oblique, the lip white, well reflexed, and convex on the face. Within the outer margin there is a somewhat retracted broad tooth, *prominent at its two ends, concave between them*. Upon the basal lip there is a less widened, more emerging *double* tooth, the outer cusp larger than the inner. The parietal wall bears an oblique, straight lamella.

Alt. 6.5, diam. 13 mm.

" 5.9, " 12 "

Bearfoot or "Bar" Park, Chiricahua Mountains, Arizona, at an elevation of 8,500 feet.

This species is an important link in the *A. levettei* chain, showing the origin of the two basal teeth by splitting of an original median one. It is less differentiated from the group of *A. thomsoniana* than the other known Arizona species.

The genitalia (Pl. XXI, fig. 23) also resemble those of *thomsoniana*. The general proportions are shown in the figure and table of measurements. The penis is comparatively long. The duct of the spermatheca is large, weakly varicose, and contracted where it joins the vagina. I did not make out any lower attachment of the penis retractor muscle.

There are about 18.10.1.10.18 teeth, nine or ten being laterals, the next three or four transitional. The ectocone is not split on the marginals, at least not on most of them.

Ashmunella angulata n. sp. Pl. XI, fig. 11; Pl. XIV, figs. 55-61, 63, 64.

The shell is lens-shaped, angular peripherally, rather narrowly umbilicate, glossy, reddish-chestnut when unworn, paler and more corneous around the umbilicus and in the middle portion of the upper surface, but frequently dull throughout by slight wear of the surface. Sculpture of very fine and irregular growth-lines, and for a short space

behind the lip there are fine, sharp striae. The embryonic whorl is glossy, with fine radial striae on the outer side of the suture; *some part or parts of the third or fourth whorls are sculptured with very minute raised points* in quincuncial order. The spire is low conic-convex, very obtuse above, the first two whorls being almost in a plane. Whorls $6\frac{1}{2}$ to $6\frac{3}{4}$, *very narrow, and very slowly increasing*; the first three are convex, *those following being decidedly flattened*, only slightly convex. *The last whorl is acutely angular at the periphery*, the angle more obtuse on its last third. The base is convex. The suture descends a little to the aperture. The lip is preceded by a creamy stripe, and the base is deeply guttered behind the expansion. The aperture is very oblique, narrow and lunate, obstructed by four teeth: a more or less sinuous, oblique parietal lamella, two compressed, entering teeth on the basal lip, of which the outer one is higher and more compressed, and an oblique, square-topped tooth within the outer lip. *The sinus or notch between the two basal teeth is slightly wider* than that between the outer basal and the outer lip tooth. The umbilicus is about one-sixth the diameter of the shell.

Alt. 14.3, diam. 6.5 mm.

“ 13.3, “ 6.3 “

“ 13.3, “ 6.4 “

“ 13, “ 6 “

“ 13, “ 6 “

Two other specimens of the type lot measure 14 and 14.3 mm. diameter respectively.

Chiricahua Mountains, Arizona, in the South Fork of Cave Creek, at the base of the mountain. Types No. 87,019, A. N. S. P., collected by Mr. Ferriss, February, 1904.

The young shells show the characteristic punctation better than adults. At resting periods in the neanic stage of growth a callous rib is formed within the lip. When this occurs early (as in the specimen figured, Pl. XI, fig. 11, 8 mm. diameter) the rib is much thicker in the middle. When it occurs in the last whorl it is more equally thickened.

This species is closely related by shell characters, but not by its soft anatomy, to *A. levettei angigyra* of the Huachuca range, agreeing with that form in the close convolution of the whorls, the angular periphery and the general arrangement of the teeth. But all fresh specimens of *A. angulata* show a quincuncial punctation of some part of the neanic whorls, not present in the Huachuca form, and the two especially differ in the shape of the whorls, the upper surface of which is flattened

in *angulata*, convex in *angigyra*. Moreover, the genitalia of *angigyra* and *angulata* differ in important respects.

As usual in *Ashmunella* and many other snails, the "species" is composed of a group of varying colonies, all living in Cave Creek Canyon and its branches. The largest and best developed of these has been taken as the type lot, Pl. XIV, figs. 55-57.

Another lot (87,015) from the South Fork of Cave Creek, "under cliffs" (fig. 58), has smaller shells of a paler dull brown tint. The whorls after the first $1\frac{1}{2}$ are flattened; and there is sometimes a low ridge making the parietal tooth V-shaped.

Alt. 12.8, diam. 6.5 mm.; whorls $6\frac{1}{2}$.

" 11.8, " 5.6 " " 6.

" 12, " 5.6 " " $6\frac{1}{8}$.

Another lot, from a different spot from the above, also consists of small shells:

Alt. 5, diam. 11 mm.; whorls 6 (2 specimens).

" 5.3, " 11 " " $6\frac{1}{2}$.

" 5.3, " 10.7 " " 6.

" 4.8, " 9.9 " " $5\frac{3}{4}$.

The following lots are from Cave Creek Canyon (the preceding being from its south fork):

No. 87,111 (fig. 61) is almost exactly like 87,015 (above).

No. 87,020 (figs. 59, 60) varies more in size and shape, as follows:

Alt. 6.3, diam. 11.2 mm.; whorls $6\frac{1}{2}$.

" 5, " 11.3 " " $6\frac{1}{2}$.

" 5, " 11 " " $6\frac{1}{2}$.

" 4.8, " 9.9 " " 6.

The punctuation of the spire is well developed.

At the Falls in Cave Creek (figs. 63, 64) the shells are like the preceding lot, except that the punctuation is less developed and the umbilicus frequently smaller:

Alt. 5, diam. 11 mm.; width of umbilicus 2 mm.

" 4.4, " 9.8 " " " 1.5 "

" 5.5, " 11 " " " 2.5 "

The genitalia of *A. angulata* (Pl. XXI, fig. 26) are figured from a specimen from the south fork of Cave Creek, No. 87,015, A. N. S. P. The penis is very short (long in *angigyra*, see fig. 28); the epiphallus, on the other hand, is very much longer than in *angigyra*; while the spermatheca and its duct are of about equal length in the two species. The vagina in *A. angulata* is rather long, as usual in *Ashmunella*, while in *A. l. angigyra* it is much shorter than in any other *Ashmunella* I have dissected.

The jaw (Pl. XXIII, fig. 15) of the same specimen is thin, with perhaps as many as eight very weak, narrow, delicate unequal ribs.

The teeth (Pl. XXII, fig. 9, a group of lateral, transitional and marginal teeth) number 16.8.1.8.16 to 18.9.1.9.18 on different parts of the same radula. There are 8 or 9 laterals and two or three transition teeth. Some of the outer marginals have the ectocone bifid.

Ashmunella ferrissi n. sp. Pl. XVI, figs. 108-110, 113.

The shell is biconvex and *acutely carinate*, narrowly umbilicate, brown, but slightly glossy, and sculptured with fine growth-wrinkles only. The spire is convex, of $6\frac{1}{2}$ very *closely coiled* and slowly widening whorls, the earliest two convex, the rest flat, with a *narrow keel projecting upward and outward above the suture*. The last whorl is concave above and below the keel, and descends very shortly to the aperture. The aperture is very oblique and obstructed by four white teeth: a wide one slightly notched at the summit, just below the peripheral angle; two compressed teeth on the basal margin, connected by a low flange on the face of the peristome; these three teeth stand about equidistant. There is also a low prominence on the lip at the position of the keel. On the parietal wall there is a straight lamella, very obliquely placed and shortly, abruptly curved inward at the axial end.

Alt. 5.5, diam. 11.3 mm.

“ 5.2, “ 11 “

Cave Creek Canyon, Chiricahua Mountains. Types No. 89,232, A. N. S. P.

This extraordinary member of the group of *A. levettei* is at once distinguished from all others known up to this time by the projecting keel above the sutures of the spire, somewhat like the Chinese *Eulota tectum-sinense* (v. Mts.), or like *Helicodonta maroccana* (Morel.).

Ashmunella walkeri Ferriss. Pl. XVI, figs. 111, 112, 117.

Ferriss, Nautilus, XVIII, p. 53, September, 1904.

The shell is *much depressed, lens-shaped, acutely carinate peripherally*, rather thin, and pale corneous-brown. The umbilicus, narrow within, *enlarges rapidly at the last whorl*. Surface lightly marked with growth-lines, but showing no trace of spiral striæ or lines. The upper surface is but slightly convex. The apex is sculptured like that of *A. levettei*. Whorls $4\frac{1}{2}$, slightly convex, the last very shortly descending in front. Base more convex than the upper surface. The aperture is small and very oblique, the lip well reflexed, white, with an obtuse, squarish tooth in the outer margin and two compressed teeth in the basal margin, the inner one smaller; these three being nearly equally spaced, or the outer two may be nearer together. There is a rather short, straight, obliquely

set parietal tooth, and in old shells a very low diverging ridge between it and the outer insertion of the lip.

Alt. $4\frac{1}{2}$, diam. $13\frac{1}{2}$ mm.

Florida Mountains, Luna county, New Mexico, in a rock talus near the top of the mountain, at an elevation of probably about 6,500 feet. Co-types in collections of J. H. Ferriss and A. N. S. P., No. 87,101.

Only a few specimens were found, and none living. While related to the carinate forms of the *A. levettei* group, and to *A. mearnsi* by the structure of the aperture, this species is flatter than any of them, and differs especially in the small number of whorls—less than in any other *Ashmunella*. It was named in honor of Mr. Bryant Walker, of Detroit.

***Ashmunella mearnsi* (Dall).** Pl. XIV, fig. 62; Pl. XVI, fig. 116.

Polygyra mearnsi Dall, Proc. U. S. Nat. Mus., XVIII, 1895, p. 2 ("Hachita Grande and Huachuca Mountains, New Mexico"); Proc. U. S. Nat. Mus., XIX, 1896, p. 343, Pl. 32, figs. 7, 8, 11; Cockerell, Nautilus, XI, October, 1897, p. 69 (Filmore Canyon, Organ Mountains, New Mexico).

Ashmunella mearnsi Dall, Ancey, Jour. of Malac., VIII, September, 1901, p. 74.

In this species an accessory parietal lamella, incipient or rudimentary in *A. walkeri* and some forms of the *levettei* series, is well developed. The lip-teeth are arranged as in the *A. levettei* group. It is nearer *A. walkeri* than any other known species, but some specimens of *A. angulata* (fig. 58) have a weak upper arm of the parietal V.

The geographic range is wide for a species of this group: the Huachuca Mountains, in southeastern Cochise county, Arizona, the Hacheta Grande Mountains, Grant county, southwestern New Mexico, and the Organ Mountains, Donna Ana county, New Mexico, east of the Rio Grande. All of these localities are near the Mexican boundary.

The specimen figured is one of those collected in the Huachuca Mountains by the well-known ornithologist Edgar A. Mearns, for whom the species was named.

The remarkable parietal armature is weakly foreshadowed in *A. walkeri*, some forms of *A. l. angigyra*, etc. The soft anatomy remains unknown.

Group of A. esuritor.

Aperture of the shell without teeth. Length of the spermatheca and its duct about 90 per cent. that of the penis, epiphallus and flagellum, which do not much exceed twice the diameter of the shell.

A single species from the Chiricahua Mountains differs strikingly from the *levettei* and *chiricahuana* groups in the proportions of the genitalia, the epiphallus being as short as in the *thomsoniana* group, while the spermathecal duct is much longer.

Ashmunella esuritor n. sp. Pl. XIII, figs. 23-26.

The shell is rather solid, light brown, biconvex, *angular at the periphery*. The cylindric umbilicus is suddenly dilated in the last whorl. The surface is irregularly marked with slight growth-wrinkles, and on the last whorl there are impressed spiral lines, more or less irregularly developed and sometimes almost obsolete. Some intermediate whorls are indistinctly punctulate. Spire low-conic. Whorls $6\frac{1}{2}$ to $6\frac{1}{2}$, slowly increasing. The first three whorls are convex, the rest more or less *flattened*. The last whorl is distinctly but not acutely angular in front, but becomes rounded in its later half. The suture descends a little to the aperture, and the whorl is rather deeply guttered behind the lip. The aperture is very oblique, roundly lunate. The peristome is white, thickened within, and equably reflexed. In the *middle of the basal margin there is a low, indistinct prominence, but there are no other traces of teeth*. The parietal callous is thin except in old specimens, when it is thickened at the edge, forming a cord across the whorl.

Alt. 7.7, diam. 15.5 mm.

" 7.7, " 15 "

" 7.5, " 15 "

" 7, " 14.5 "

" 7.7, " 14 "

Chiricahua Mountains, in Bar (or Bearfoot) Park. Types No. 87,023, A. N. S. P., collected by James H. Ferriss, February, 1904.

At first glance this form seems to be a small angular race of *A. chiricahuana*; but upon closer study it seems far more likely that it is a terminal member of the *A. angulata* group, in which the teeth have degenerated. The slight flattening of the whorls, the shape of the mouth, and a faint punctation observable near the end of the third whorl in the freshest specimens, all indicate this relationship. Most of the fully adult and old individuals seen have lost much or all of the cuticle, and are dull flesh-tinted.

The spiral engraved lines vary a good deal in different specimens, and when slightly corroded neither spirals nor granulation are visible, even in living shells.

The smaller size, angular periphery and comparatively wider lip readily distinguish *A. esuritor* from *A. chiricahuana*.

The genital system (Pl. XXI, figs. 30, 25) resembles that of *A. chiricahuana* except that the ducts are very much shorter, both absolutely and in comparison with the size of the shell; and the spermatheca and its duct are nearly as long as the penis, epiphallus and flagellum. The extruded penis and atrium in another specimen are shown in fig. 25.

The penis has low, slowly spiral ridges. The entire length of the organs exerted is about 3.2 mm.

The jaw has about 7 unequal ribs.

The teeth number about 16.12.1.12.16, the tenth to thirteenth being transitional. Both cusps of the marginal teeth are bifid.

Five shells taken in Sawmill Canyon, running from Bear Park, Chiricahuas, are like the types. The periphery in some is not quite so angular. The punctulation is identical. Two measure:

Alt.	7.5	7 mm.
Diam.	16.3	14 "
Whorls	6 $\frac{1}{2}$	6 $\frac{1}{4}$

Group of A. chiricahuana.

Aperture toothless. Epiphallus and duct of the spermatheca very much longer than in species of any of the other groups, the diameter of the shell contained four times in the length of the penis, epiphallus and flagellum.

Ashmunella chiricahuana (Dall). Pl. XVI, figs. 96-100.

Polygyra chiricahuana Dall, Proc. U. S. Nat. Mus., XVIII, p. 2, 1895 (Fly Park, Chiricahua Mountains); Proc. U. S. Nat. Mus., XIX, p. 341, Pl. 32, figs. 9, 10, 12, 1896.

Ashmunella chiricahuana (Dall), Pils. and Ckll., Proc. Acad. Nat. Sci. Phila., 1899, p. 192; Ancey, Jour. of Malacol., VIII, September, 1901, p. 76, with var. *varicifera*, p. 77.

This species has the general shape and rounded periphery of *A. levettei*. It varies from chestnut to rather light greenish-brown, and shells which have lost their cuticle are dull flesh-colored. It is very glossy and smooth, marked with weak growth-wrinkles and engraved spirals, which are distinct in some, almost obsolete in other specimens. Under the compound microscope fine spiral striæ are seen to cover the surface between the spiral lines. Whorls about 5 $\frac{1}{2}$, slightly convex. The last descends a trifle in front, and is somewhat constricted behind the lip. The aperture is without teeth. *The lip is narrow, reflexed, brownish above and at the edge, without trace of lip-teeth.* The umbilicus opens rather widely at the last whorl.

There is almost always an opaque yellow stripe on the last whorl, marked inside by a strong white rib, and indicating a place of growth-arrest. Some shells have several such variceal streaks on earlier whorls also. The feature is a variable one in shells of the same lot, for reasons I have elsewhere discussed in full. In one lot of 16 specimens from Cave Creek Canyon, Chiricahuas, there are 3 specimens with a single streak on last whorl, 8 with 2 streaks on last 2 whorls, 4 with 3 streaks on last 3 whorls, and 1 with 4 streaks on last 3 whorls.

Type locality, Chiricahua Mountains, southeastern Arizona, in Fly Park, 10,000 feet altitude (Fischer); also in Cave Creek Canyon (Ferriss, 1904). The locality "near Tucson" is also given for specimens collected by a Mr. Cox, many years ago. ?Huachuca Mountains, in Miller Canyon (see below).

Dall's type measured, alt. 7.7, diam. 18 mm.³ Three topotypes of the original lot collected by Fischer measure:

Alt. 9, diam. 18 mm.; whorls $5\frac{3}{4}$.

" 8.5, " 16 " " $5\frac{1}{2}$.

Sixteen of the specimens collected by Mr. Ferriss in Cave Creek Canyon (Pl. 16, figs. 96-100) measure:

Alt.	10	9.5	10	9	10	8.8	8.5	9.5
Diam.	20.5	20	19	19	18.5	18.5	18.5	18
Alt.	9	9	9	8.5	8.3	8.2	9	8.5
Diam.	18	18	18	18	18	18	17.7	17.5

The diameter curve from this small series has a strongly marked mode at 18 mm. (44% of the whole), with a skew toward the smaller diameter.

There is a considerable variation in the height of the spire, shown in the measurements above and in the figures, of which figs. 99 and 100 represent about the extremes of variation in this respect.

Two specimens from the head of Miller Canyon, in the Huachuclas, measure 8.5 x 18.2 mm. and 8 x 16 mm. The smaller one is an albino, greenish-white. These may be referable to *A. levettei heterodonta*, q. v.

I have seen no Ashmunellas from Tucson, but no differential characters have been indicated for the variety *varicifera* Ancey, from that place. Nearly all the specimens from the Chiricahua range have varices.

The genital system (Pl. XXI, fig. 29) is remarkable for the great length of the epiphallus, vagina and spermatheca duct. The penis is large and well developed. The specimens examined are from Cave Creek Canyon, in the Chiricahuas.

The jaw (Pl. XXIII, fig. 13) is stronger than in most of the species, with 8 strong ribs and several weaker ones.

The radula (Pl. XXII, figs. 10, central and lateral, and 11, groups of transitional and marginal teeth) has 16.13.1.13.16 or 16.14.1.14.16 teeth. The thirteenth to fourteenth or fifteenth teeth are transitional.

³ This measurement was not to the base of the lip, and hence is less than in the shells from the same lot measured by me.

The fifteenth tooth has the mesocone bifid. As a rule, the marginal teeth have the ectocone simple, but I found a few teeth in some rows having a bifid ectocone.

Ashmunella chiricahuana mogollonensis n. subsp. Pl. XVI, figs. 101, 102.

Similar to *chiricahuana* but slightly more tumid, dull greenish-brown, not glossy. Surface sculptured with low, irregular, coarse wrinkles of growth, and *distinct, clear-cut incised spirals* all over the last whorl. Spire very low, the early whorls depressed.

Alt. 9, diam. 17.5 mm.; whorls $5\frac{1}{2}$.

West fork of the Gila river, near Mogollon Peak, in the southwestern part of Socorro county, New Mexico, in a pine region, collected by Prof. E. O. Wooton, August 7, 1900, sent by Prof. T. D. A. Cockerell. Type No. 79,530, A. N. S. P. (fig. 102). A specimen has also been taken by Mr. O. B. Metcalfe near Kingston, Sierra county, New Mexico (fig. 101).

In *A. chiricahuana* the spirals are very much weaker or obsolete, and the cuticle, when in unworn condition, is conspicuously glossy.]

Group of A. metamorphosa.

Shell edentulous, similar to *A. chiricahuana*. Genitalia peculiar, see below.

Ashmunella metamorphosa n. sp. Pl. XVI, figs. 114, 115.

Shell similar in form and color to *A. chiricahuana* and *A. esuritor*. Surface slightly marked with growth-lines and very minutely engraved spirally when unworn, but the spirals cannot be seen on slightly corroded living shells. Whorls $5\frac{3}{4}$ to $6\frac{1}{2}$, convex, slowly widening, the last rounded peripherally, slightly descending in front, contracted behind the reflexed and slightly recurved lip. Umbilicus a trifle less open than that of *A. chiricahuana*. Aperture like that of *A. chiricahuana* in shape, but in some specimens there is a low callous within the outer lip, and one or two indistinct callouses within the basal margin, while in others these are hardly noticeable.

Alt. 9, diam. 17 mm., or slightly smaller alt. 8.9, diam. 16.5 mm.

Bear (Bearfoot or Barfoot) Park, Chiricahua Mountains, Cochise county, Arizona. Types No. 88,885-6, A. N. S. P., collected by Mr. J. H. Ferriss, 1904.

Genitalia (Pl. XXI, fig. 27) with a very short atrium. There is no differentiated penis, the ♂ organ being of *equal calibre throughout, and evidently an epiphallus*. It terminates in the usual very short flagellum. I can find *no trace of a penial retractor muscle*. The very long vagina consists of a *very slender lower portion and an excessively thick, muscular*

upper part. The spermatheca is long and narrow, its duct rather short. The epiphallus and flagellum measure 22 mm.; flagellum 2 mm.; spermatheca and duct 20 mm. The specimens had been placed in alcohol without drowning.

The jaw (Pl. XXIII, fig. 16) has seven ribs, grouped in the median half, the ends smooth.

The radula (Pl. XXII, fig. 8) has about 38.138 teeth. The ectocones are developed on central and lateral teeth. From the twenty-fourth or twenty-fifth teeth outward from the middle the inner cusp is bifid. The ectocones are unsplit. A central and two lateral teeth are shown.

This snail, so far as the shell is concerned, would be referred without hesitation to *A. chiricahuana*; the differences being less than the ordinary range of individual variation in *Ashmunella* or *Polygyra*; but the genitalia are so utterly unlike in the two forms that it is obvious that they are not even nearly related. From the granulation and the weak traces of teeth it seems that *A. metamorphosa* is probably a toothless derivative of the *A. levettei* stock; I regret that I have no alcoholic specimens of *A. levettei* or *A. l. heterodonta* for comparison. *A. esuritor* differs from *metamorphosa* by its angular or distinctly subangular periphery, rougher surface when perfectly fresh, and perhaps somewhat wider umbilicus; but it must be admitted that the two forms are so similar that their distinction may be difficult without an examination of the soft parts. The genitalia, however, are so very different that the two species cannot even be closely related. They must be independent derivatives from toothed ancestral forms.

I dissected two of the three specimens received. They could be extracted only by breaking into the shell. Having been preserved in alcohol without drowning the specimens were much more contracted than the *A. chiricahuana* and *A. esuritor* I examined. A somewhat extensive experience with snails in all conditions of preservation has shown that beyond a moderate diminution of the absolute size, the characters of the genitalia are not altered by preservation of the animal in strong alcohol.

Genus **SONORELLA** Pilsbry.

Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 556 (definition, anatomy);
Bartsch, Smiths. Misc. Coll., Vol. 47, p. 187, 1904 (monograph).

The soft anatomy of this genus has hitherto been known in a single species. The study of numerous specimens of several species enables me to extend the generic characterization.

The shells in these *Helices*, while interminably modified locally in

size and minor details of shape and sculpture, show with few exceptions no prominent specific differentiation. On the other hand, in the internal anatomy there has been a good deal of divergence. A few forms, such as *S. lohrii* Gabb and *S. wolcottiana* Bartsch, seem to be quite distinct conchologically, but in many cases the determination of specimens of the shells other than the type localities is so uncertain as to be little better than guesswork, even when types are available for comparison. In dealing with these ambiguous forms I have thought the interests of science best furthered by applying specific names only to those I am able to characterize anatomically, and thus put upon a secure basis.

An illustrated monograph of *Sonorella*, dealing with the shells only, has been published by Mr. Paul Bartsch, who has devoted great industry to the elucidation of the numerous species and races. The work is of permanent value for its exact descriptions and excellent figures, both of which I have had occasion to test; but it deals with selected or "type" specimens only, ignoring the fact of variation, and hence fails to give a just idea of the complex of varying forms which exist, or even of the variations of size, etc., occurring in the type lots. I would here express my indebtedness to Mr. Bartsch for his invariable kindness in comparing for me various forms of *S. hachitana* with specimens in the U. S. National Museum.

Mr. Bartsch has made the valuable observation that the embryonic shells of *Sonorella* are sculptured, usually with oblique forwardly descending threads, or with two sets of intersecting threads, sometimes interrupted to form papillæ at their intersections. This sculpture may, I think, be the accelerated vestige of a somewhat similar sculpture characteristic of the Californian *Helices* in their adult stage, and which may thus have been common to the ancestral *Sonorellas*.

The relationships of *Sonorella* are primarily with *Oreohelix* and *Ashmunella*. It differs from *Oreohelix* chiefly in the different proportions of the kidney and pericardium, but also in the structure of the shell, the oviparous reproduction, the unkeeled young shell, and in the distinctly ribbed jaw.

Sonorella stands nearer *Ashmunella* in internal anatomy, but there is a constant difference in the male organs, the penis being well developed in *Sonorella*, while in *Ashmunella* it is more or less completely degenerate, the epiphallus being hypertrophic. The divergence between the shells of the two genera is conspicuous. So far as the shell is concerned, *Sonorella* stands nearer to the generally prevalent type of Belogonous *Helices* than do either of the other genera.

Generic Characters of Sonorella.

The genitalia (Pl. XX) show no accessory organs on the female side. The vagina is long; the spermatheca is globular or ovate on a very long slender branchless duct. The atrium is always extremely short. The penis is a well-developed, thin-walled tube, containing a large papilla, and terminating in a well-developed epiphallus. There is always a loose sheath or wide collar enveloping the base of the penis, and attached by muscular threads to the end of the epiphallus, which is thus held loosely in a reflexed position. This sheath has been removed in most of my figures, as it obscures the parts enveloped.

The retractor muscle is attached to the epiphallus close to the penis, and is adnate to or envelops it to the apex of the latter. The flagellum is extremely short, or even absent. The details of structure are much varied in the several species as described below under each specific caption, and in the table of measurements.

The free muscles, pallial complex and digestive tract have been described in these *Proceedings* for 1900, p. 558. No material differences have been observed in additional species examined.

The jaw has four to eight ribs grouped in the median part, and either strong or weak, as in the Californian *Helices* (Pl. XXIII, figs. 18-23).

The radula has unicuspid middle and lateral teeth, bicuspid transitional and inner marginal teeth and low, wide marginals with both cusps bifid. Exactly the same type of teeth occurs in the Californian *Epiphragmophoras*, in *Ashmunella*, *Polygyra*, etc.

The upper surface of the foot is densely pebble-granose, with rather indistinct dorsal grooves; the genital furrow is undeveloped except near the mantle. The tail is depressed, rather long, and sometimes has a weak median impressed line along the top.

In my original diagnosis of *Sonorella* I stated that the shell was "neither malleate nor spirally striate." Mr. Bartsch has also asserted that "incised spiral lines are never present in this genus." This statement must now be withdrawn, since several forms discovered by Mr. Ferriss show impressed spiral lines; but they are inconspicuous, and visible only under the lens.⁴ To the eye, the shells of all known *Sonorellas* appear nearly smooth, the sculpture, aside from slight growth-wrinkles, being microscopic. This is somewhat remarkable because they often live in the same rock-piles with rudely sculptured *Oreohelices*.

⁴Mr. Bartsch has excluded *Helix carpenteri* Newc. from *Sonorella* on account of its spiral sculpture; but since I have found that this is not a diagnostic character of the genus, I am disposed, pending an examination of the soft anatomy, to adhere to my former opinion that *carpenteri* belongs to *Sonorella*.

Up to this time, no carinate or even strongly angular species have been found. Such uniformity in the shell is unusual in a Helicid genus.

The characters of the soft anatomy originally attributed to the genus have proved to prevail in the more extensive material now examined, except that in one species the flagellum is obsolete. The penis was incorrectly described in my original diagnosis, through my failure to open it, and thus ascertain the exact limits of penis and epiphallus.

Measurements of the Genitalia in Millimeters.

<i>Species</i>	<i>Penis</i>	<i>Penis- papilla</i>	<i>Free epi- phallus and fla- gellum</i>	<i>Fla- gellum</i>	<i>Va- gina</i>	<i>Sperma- theca and duct</i>	<i>Mu- seum num- ber</i>
<i>S. hachitana</i> , Florida Mountains	9	4	7	0.5	10.5	29	86,496
<i>S. h. ashmuni</i> , Purtyman's ranch	11	6	7	0.7	9	29	79,409
<i>S. h. ashmuni</i> , Purtyman's ranch	11	.....	6.7	0.7	8	35	79,409
<i>S. h. bowiensis</i> , Bowie	10	3	8.5	0.6	10	.....	86,497
<i>S. rowelli</i> , Sanford's	5	2	5.5	vesti- gial	5.3	20	83,273
<i>S. rowelli</i> var. Patagonia Mountains	4	.....	.....	want- ing	4.5	.....	83,268
<i>S. granulatissima</i> , Huachuca Mountains	7.3	* 4.8	6	0.7	21	24-25	83,257
<i>S. virilis</i> , Chiricahua Mountains	34	29	23	1	16	24	79,622
<i>S. v. circumstriatus</i>	24	.....	21	0.8	20	.....	87,026

Helix remondi Tryon belongs to another genus, still uncharacterized anatomically, of the Belogona Euadenia. A living specimen sent me by mail some years ago was crushed *en route*, partially decayed and dried hard when it reached me. I soaked up the remains, and found that the tail has a strong serrate keel above; there is a slender, cylindric-fusiform penis, but the rest of the genitalia were impossible to make out. The radula does not differ materially from the *Epiphragmophora* type. In Mexico, the genus *Lysinoe* and at least one species of *Leptarionta* have the same extremely unusual structure of the tail.

Neither is much like *H. remondi* conchologically; but further information on both *H. remondi* and *Leptarionta* is needed.

Sonorella hachitana (Dall). Pl. XVII, figs. 1-8.

Epiphragmophora hachitana Dall, Proc. U. S. Nat. Mus., XVIII, p. 2, 1895; XIX, p. 338.

Sonorella hachitana Dall, Pilsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 557 (as type of *Sonorella*).

S. hachitana Dall, Bartsch, Smiths. Misc. Coll., XXXXVII, p. 190, Pl. 31, fig. 2 (shell), and Pl. 29 (apex), 1904.

Probably includes as subspecies *S. ashmuni* Bartsch, l. c., p. 190, Pl. 31, fig. 5; *S. nelsoni* Bartsch, l. c., p. 191, Pl. 31, fig. 3, and *S. goldmani* Bartsch, l. c., p. 192, Pl. 32, fig. 6.

This is a widely distributed species in central and southeastern Arizona and southwestern New Mexico. It varies in size, degree of depression, width of umbilicus, size of aperture, and in color-tone; also in some measure in the sculpture; but so multifarious are the connecting links that I do not now see my way to support the dismemberment proposed by Mr. Bartsch. It will doubtless be found useful to recognize by name a half-dozen or more local races.

The internal anatomy of the types, from Hacheta Grande Mountains, Grant county, New Mexico, is not known, nor have topotypes been dissected. I have been able, however, to examine several specimens from other localities, which conchologically differ very little from the original lot of *hachitana*, some of which are before me.

The name "hachitana" seems to be a perverted form of that of the locality, "Big Hatchet." The Spanish name, locally in use, and appearing on most maps, is "Hacheta Grande."

1. Filmore Canyon, Organ Mountains, New Mexico (Pl. XVII, figs. 7, 8). A single specimen sent by Prof. Cockerell measures alt. 13.8, diam. 23.5 mm., umbilicus 3.2 mm. The aperture is ample, 11.8 x 13.3 mm., as in the large shells from Florida Mountains. This specimen has been referred by Mr. Bartsch to his *S. nelsoni*, which measured 25.5 x 13.4, umbilicus about 4 mm., aperture 11.1 x 12.8 mm., and is said to differ from *hachitana* in being "more depressed and has a larger aperture."

The genitalia show that the specimen, while full grown, is not quite mature, the male organs especially being thread-like. The spermatheca is globular, on a very slender duct. The specimen is No. 71,413, A. N. S. P. It has been referred by Mr. Bartsch to *S. nelsoni*.

The jaw (Pl. XXIII, fig. 19) has eight narrow equal ribs.

2. Florida Mountains, near Deming, Luna county, New Mexico. Mr. Ferriss states that these specimens were collected in a very barren, arid locality. Very large specimens were taken measuring 28.3 x 15.9

mm., width of umbilicus 4.7 mm., or even larger 29.5 x 15.5 mm. They exceed *S. ashmuni* Bartsch in size, and are larger than any *Sonorella* on record (Pl. XVII, figs. 1, 2). The aperture is ample, 12.9 x 14.5 mm.

Another lot (86,496, A. N. S. P.), figured on Pl. XVII, figs. 3-6, from the same locality, consists of smaller specimens. Some are typical *hachitana* in form and size except that the last whorl descends more deeply in front, making the aperture subhorizontal in some specimens (figs. 5, 6). In a few specimens the suprapерipheral band is almost obsolete, very narrow and interrupted (figs. 3, 4), but most of them are pale reddish-brown, fading to white in the middle region of the base, and with a white or whitish band on each side of the dark suprapерipheral belt.

Alt. 14.5, diam. 25.4, width of umbilicus 4 mm.

" 14.3,	" 27.7,	"	" 4	"
" 13,	" 26.7,	"	" 3.9	"
" 13.9,	" 26,	"	" 4	"
" 13.7,	" 26,	"	" 3.9	"
" 13.3,	" 23.5,	"	" 3	"
" 13.3,	" 23.4,	"	" 2.9	"
" 12.6,	" 22	"	" 3.9	"
" 10.7,	" 22,	"	" 3.8	"

Specimens of this lot were sent alive.

The pale sole is indistinctly tripartite, extremely weak impressed lines dividing it in some specimens, not traceable in others. The back is slate or blue-blackish, the tail brown above, paler toward the foot-edges. The surface is finely pebble-granulate. There is a pair of indistinct dorsal grooves, and the genital furrow is traceable only near the mantle. The tail is depressed, with a very faint median groove.

The genitalia (Pl. XX, fig. 12) show no differences of any moment from the form of *hachitana* from Purtyman's ranch, Arizona, figured by me in 1900, except in the shape of the spermatheca, which, however, is not constant in the Purtyman's lot. The individuals examined were partly not fully developed, and possibly older specimens will show a somewhat stouter vagina and penis than that figured. The penis papilla is long and slender, not convoluted in the specimen opened.

The jaw (Pl. XXIII, fig. 20) has eight ribs.

The radula is somewhat unlike other *Sonorellas* examined in the central tooth, which is narrower than the adjacent laterals. There are 55.1.55 teeth, an ectocone appearing on the fifteenth. Both cusps are bifid on most of the marginal teeth, the mesocone + entocone being

very oblique and unusually long in the inner marginals. This radula differs a good deal from that of the Purtyman's ranch form, in both count of the teeth and in some details of their shape; but these features are admitted by all who have examined many radulae to vary so widely among individuals that their value is largely discounted. The discrepancy between the forms should be controlled by the examination of several of each form.

Sonorella hachitana ashmuni Bartsch. Pl. XVII, figs. 9-14.

Sonorella hachitana, specimens from Oak creek, Purtyman's, Arizona, Pillsbry, Proc. Acad. Nat. Sci. Phila., 1900, p. 557, Pl. 21, figs. 1-5 (anatomy).

Sonorella ashmuni Bartsch, Smiths. Misc. Coll., Vol. 47, p. 190, Pl. 31, fig. 5 (1904).

Purtyman's ranch, on Oak creek, 40 miles from Jerome, in the eastern edge of Yavapai county, Arizona. Collected by Rev. E. H. Ashmun, 1900 (No. 79,409, A. N. S. P.).

These specimens furnished the anatomical preparations described by me (*Proc. Acad. Nat. Sci. Phila.*, 1900, p. 557, Pl. XXI, figs. 1-5). Specimens of this lot have been examined by Mr. Bartsch and pronounced by him to be "a small race of *S. ashmuni*. They bear the same relation to *ashmuni* that *S. mearnsi* bears to *S. dalli*." I would prefer to make an immaterial change in this statement. I would say that *S. ashmuni* represents a large race or colony of *S. hachitana*, and the Oak creek lot is nearly typical *hachitana*.

The specimens are well-developed shells, often larger than typical *hachitana* from Hacheta Grande Mountains. Nearly all are banded, whitish above and below the band; but 3 out of 350 collected by Mr. Ashmun at this place lack the dark band (figs. 13, 14). Specimens measure:

Specimens:	a	b	c	(<i>hachitana</i>)	d	e	f	
Alt.	13	13.4	13.5	(13.5 12)	13.3	13	13	mm.
Diam.	23	22.8	22.5	(22.7 22.2)	22.5	23.3	22	"
Alt. apert.	10.7	10	10.1	(9.6 9.9)	9.9	10.3	10	"
Diam. apert.	12.3	10.5	11.7	(11.9 10.7)	11.7	12	11.3	"

Compare with the measurements in parentheses of topotypes of *hachitana*, part of the original lot, received from Dall.

In general the aperture in the Purtyman ranch shells averages larger than in typical *hachitana*, but no hard and fast line can be drawn, and selected individual specimens of each are simply indistinguishable, either by measurements, color or any other character. The most we can claim for *S. ashmuni* is the rank of a weakly differentiated local race of *S. hachitana*, chiefly separable in actual practice by its geographic

distribution. The radula has fewer teeth in a transverse row than in the *hachitana* from the Florida Mountains near Deming, New Mexico; but only one radula from each locality has been examined.

The color and other external features of the foot are as described for *S. virilis*. The internal anatomy was described and figured in my paper of 1900, Pl. XXI. The spermatheca in another specimen of the same lot was globular, as in other Sonorellas, not ovate with thickened duct as in the individual figured, which was stuffed with spermato-phores. The penis was wrongly described in my former article. I did not then open it, and considered its upper portion to be epiphallie. When opened (Pl. XX, fig. 15) it is found to be a long, thin-walled sack, the upper half containing a long, slender, more or less convoluted papilla (*p.p.*). This is a little longer than in the *hachitana* examined from the Florida Mountains. Otherwise the genitalia are practically the same in the Florida Mountains and Purtyman's ranch snails.

Sonorella hachitana bowiensis n. subsp. Pl. XVIII, figs. 29-32.

The shell is similar to *hachitana* but is much smaller, with $4\frac{1}{2}$ to $4\frac{1}{2}$ whorls. The suprapapillary band shows on about $2\frac{1}{2}$ whorls, above the suture on the spire; on the last whorl it has very faint, inconspicuous pale borders or none. No spiral lines are present in most specimens, but in two they may be seen very faintly, near the periphery. Seven fully adult shells measure:

Alt.	9.9	9.9	9.8	10	9.2	9.7	8.7 mm.
Diam.	17.8	17	17.5	17	17.2	16.6	15 "
Alt. apert.	8.2	7.8	8	8	7.7	7.7	6.9 "
Diam. apert.	9.5	9	9.2	9	9	8.4	8 "

Bowie, Cochise county. Types No. 86,497, A. N. S. P., collected by James H. Ferriss, 1904. Specimens were also taken by Mr. Ashmun at the same place. Mr. Ferriss writes that they were taken "in a situation exceedingly favorable for snails."

The genitalia (Pl. XX, figs. 10, 11) show externally only slight differences from *hachitana*. The penis and epiphallus are comparatively a little longer. Internally, however, the penis differs in having a short, obtuse papilla, only about 3 mm. long (Pl. XX, fig. 10), while in the forms referable to *hachitana* the papilla is twice as long, slender and tapering. These features, which I have confirmed in a number of individuals, indicate a certain amount of racial differentiation which may properly be recognized in nomenclature.

The jaw (Pl. XXIII, fig. 22) has four low, wide, unequal ribs and some minor riblets.

The radula is like that of Purtyman's ranch *hachitana* in general features. The twelfth lateral shows a small ectocone, larger on succeeding teeth.

Sonorella rowelli (Newcomb). Pl. XVIII, figs. 33-35.

Helix rowelli Newc., Proc. Cal. Acad. Sci., III, p. 181 (January, 1865).

S. rowelli (Newc.), Pilsbry, Proc. Acad. Nat. Sci. Phila., 1902, p. 511.

Shell like *S. hachitana*, but small, with large mouth and small umbilicus. Corneous-brown, with a dark band above the periphery, indistinct pale borders above and below it; somewhat translucent, thin. Whorls nearly $4\frac{1}{2}$, convex, the first (embryonic) $1\frac{1}{2}$ whorls nearly smooth, sculptured with some slight radial wrinkles only; following whorl or whorl and a half showing some indistinct granulation in places; last whorl with growth-lines only, rounded peripherally, descending a little in front. The aperture is large, subcircular, oblique, the thin whitish peristome being very narrowly expanded, columellar margin dilated. Umbilicus comparatively narrow, partially covered by the columellar lip.

Alt.	9.9	9.6 mm.
Diam.	17.1	16.6 "
Umbilicus	2.5	2.1 "
Alt. apert.	8.5	8.7 "
Diam. apert.	9.5	9.5 "

Sanfords, near the eastern border of Pima county, southeastern Arizona. No. 83,273, A. N. S. P., collected by James H. Ferriss, 1902 (figs. 33, 34).

Genitalia (Pl. XX, figs. 13, 14). The penis is short, containing a short, cylindric, obtuse papilla. The free portion of the epiphallus is about equal to the penis in length. The *flagellum* is reduced to a mere *tubercle*, being much shorter than in any other *Sonorella* yet dissected. The vagina is about as long as the penis, and the spermatheca and its duct are about four times as long.

The jaw has 6 or 7 narrow, unevenly spaced ribs.

The radula has 44.144 teeth, like those of *S. granulatissima*. The eleventh and twelfth are transitional.

The last whorl is less deflexed than in *S. h. bowiensis*, the aperture is larger and the umbilicus smaller. Both penis and vagina are decidedly shorter, though their proportionate lengths do not differ materially, and both have the penis-papilla short and obtuse; but in *S. rowelli* the flagellum is reduced to a minute vestige, unlike any of the other species. The remarkable constancy of this organ in the large number of individuals of *Sonorella* and *Ashmunella* which have been

under my scalpel, gives reason for considering its modification in this species of importance.

I have identified these shells with *S. rowelli* (Newc.), a species said to have been collected in Arizona by Frick, many years ago. *S. arizonensis* (Dall), from Tucson, is more elevated, but is probably related to *rowelli*.

A form collected by Dr. G. H. Horn, the coleopterist, at Fort Grant, Arizona, is closely related to the shells described above.

In the Patagonia Mountains, a short distance eastward from the locality of *S. rowelli*, a smaller form of the species was collected by Mr. Ferriss (Pl. XVIII, fig. 35), and also by Mr. Ashmun. The umbilicus is narrower and more covered by the dilated lip than in Sanford's *rowelli*, and the last whorl descends more deeply in front. The shells measure:

	83,268, Ferriss coll.		73,604, Ashmun coll.		
Alt.	9	8	8	8	8 mm.
Diam.	15.4	14	14	14	13.5 "
Alt. apert.	7.8	6.9	6.8	6.8 "
Diam. apert.	8.5	7.8	7.7	7.5 "

One of Mr. Ferriss' specimens (fig. 35) was sent alive, and proves to be like the Sanford's *rowelli* anatomically, differing merely in the smaller size of all the organs, except that there is no perceptible flagellum (Pl. XX, fig. 20, the terminal ducts only are drawn). The jaw (Pl. XXIII, fig. 18) has about 6 narrow equal ribs.

The type measurements of *H. rowelli* given by Newcomb are alt. .4, diam. maj. .6, min. .5 inch., about equal to 10, 15, 12.5 mm. The type is in the collection of Cornell University.

Sonorella granulatissima Pils. Pl. XVII, figs. 21-23.

Nautilus, XVI, p. 32, 1902.

Bartsch, *Smiths. Misc. Coll.*, Vol. 47, p. 193, Pl. 32, fig. 4.

The shell in the co-types of this species is thin, pale, with a rather wide dark chestnut band without white borders, and visible above the suture on the last $2\frac{1}{2}$ or 3 whorls. The surface is very minutely and very densely granulated over the usual low growth-wrinkles. Near the periphery some faint traces of spiral lines may be deciphered in places, but they are so slight that they would have been overlooked if not especially looked for. The umbilicus is small. The two co-types measure:⁵

⁵ These measurements differ slightly from those given in the original description, due to the fact that at that time I used only a flat millimeter rule, upon which it is, I find, impossible to read correctly the dimensions of globose shells.

Alt.	10.4	10 mm.
Diam.	19	18.5 "
Alt. apert.	9.5	8.7 "
Diam. apert.	10.4	9.7 "
Umbilicus	2.5	2.7 "

They are from "Spring Canyon," near Fort Huachuca, No. 83,257, A. N. S. P.

The sole is indistinctly tripartite, the middle field ochraceous, the sides dusky; the colors separated by very faint lines. The upper surface is blackish-gray, evenly pebble-granose. A subobsolete dorsal line is discernible, and a very weak line on the tail, not quite median.

The two co-types were dissected. The genitalia (Pl. XX, figs. 16, 17, 18) are characteristic by the proportions of the penis and vagina. The penis is short, cylindric, composed of a thin-walled sack containing a large, fleshy, cylindric papilla (fig. 18). Epiphallus and flagellum (fig. 16) as usual. The vagina is large, *very long* and muscular, *about three times the length of the penis*. Its upper portion is swollen and sometimes fusiform. Other organs as usual (see table of measurements).

The jaw (Pl. XXIII, fig. 23) has four very wide, low, flat ribs.

The radula has 36.1.36 teeth, the central and inner laterals unicuspid, the eleventh showing a minute ectocone. Most of the marginal teeth have both cusps bifid.

2. Brown's Canyon. One specimen similar to those from Cave Creek, Ida and Bear Canyons, 11.8 x 19 mm.

3. Ramsey Canyon. The shells are darker than the types, beautifully granulated, and show distinct spiral lines on the top of the last whorl. Umbilicus typical.

4. Carr Canyon (Pl. XVIII, figs. 51-54). These shells show the spiral lines more or less distinctly. They are otherwise typical, but vary a good deal in size.

5. Miller Canyon (Pl. XVIII, figs. 41, 42, 43). Of a rich dark reddish color with a wide darker band, well granulated and showing weak or excessively faint spirals. More depressed than any other *granulatissima* seen; and in some specimens the umbilicus is decidedly wider, 3 mm. in a shell 18.5 mm. diameter.

There were also some much lighter, greenish-yellow shells taken in Miller Canyon (Pl. XVIII, figs. 39, 40, 44). They are much depressed, with a wide umbilicus and very distinct spiral striation (Pl. XI, fig. 10). They photograph abnormally dark.

	(Ramsey Canyon)				(Carr Canyon)		
Alt.	10.7	11	11.1	11.8	10.8	10.2	11.3
Diam.	19.9	19.5	19.2	20.5	18.8	17.5	17.7

	(Miller Canyon)		
Alt.	11.5	10.7	9 mm.
Diam.	20	19.6	18.5 "

6. On the south side of the range, specimens were taken in Cave Creek Canyon, typical in form and sculpture, but larger, 12.6 x 20.8 mm.

7. Ida Canyon (Pl. XVIII, figs. 36, 37, 38). Typical in shape and color, but with slightly effaced granulation, very weak spirals, and variable size.

Alt.	11.9	10.4	9.3 mm.
Diam.	21.3	19.8	17.8 "

8. Bear Canyon. Similar to the Cave creek form, 11 x 19.3 mm., or more depressed, like Miller Canyon shells, 10.7 x 20.8 mm.; umbilicus 2.9 mm.

Sonorella granulatisissima parva n. subsp. Pl. XVIII, figs. 45-47.

Shell with the sculpture of *S. granulatisissima*, but much smaller, and subangular at the periphery. Whorls $4\frac{1}{2}$, convex, parted by well-impressed sutures, the last moderately descending in front. The band is wide, without pale borders, and is visible on two or two and a half whorls.

Alt.	9.3	10	9 mm.
Diam.	16	16	15.2 "
Alt. apert.	7.4		"
Diam. apert.	8.3		"
Umbilicus	2.4		"

West end of the Huachuca Mountains, between Fort Huachuca and Manilla Mine. Types No. 87,114, A. N. S. P., collected by James H. Ferriss, 1904.

Eleven specimens of this small form were obtained at the place mentioned. It is chiefly notable for the subangular periphery, very unusual in *Sonorella*. It is very similar to *S. mearnsi* Bartsch, differing in the wider umbilicus and more oblique aperture. *S. mearnsi* may prove to be a subspecies of *S. granulatisissima*, but its internal anatomy is unknown.

Sonorella granulatisissima latior n. subsp. Pl. XVIII, figs. 24-28.

This form is very similar to *S. granulatisissima*, from which it differs in the usually larger size and the more depressed last whorl. The granu-

lation is finer and less distinct than in typical *granulatissima*, and the umbilicus is slightly wider. The suprapерipheral band is wide, and has no paler borders. There are $4\frac{3}{4}$ whorls, the last rather deeply deflexed. The embryonic shell is sculptured as in *S. hachitana*.

Alt.	12.	12	12.4	12	12
Diam.	23.6	23	22.6	22	22
Alt. apert.	11	10.5	10.8	9.8	10
Width apert.	11.7	12.2	12	11.4	12
Width umbilicus	3.2	.....	2.6	3.3	3
Alt.	11.7	11.2	11.7	12.2 mm.	
Diam.	22	21.9	21.3	20.5 "	
Alt. apert.	10.7	10	9.8	9.4 "	
Width apert.	11.9	11.5	11.2	10.9 "	

Huachuca Mountains, in Brown's Canyon. Types No. 87,083, A. N. S. P., collected by James H. Ferriss.

The soft anatomy is unknown, but the form, while not conspicuously differentiated, is yet readily distinguishable from *S. granulatissima*. Specimens sent to Mr. Bartsch were pronounced by him to "stand half way between *S. dalli* and *S. granulatissima*."

***Sonorella dalli* Bartsch.**

Smiths. Misc. Coll., Vol. 47, p. 193, Pl. 21, fig. 1 (October 10, 1904).

This form is somewhat larger and more depressed than *S. g. latior*. It is described as with "numerous microscopic granulations," but in one of the type lot kindly presented by Dr. Dall these are hardly appreciable. The type measurements are alt. 12, diam. 26.5, aperture 10.5×11.8 mm.; and Mr. Bartsch has kindly supplied the diameters of the rest of the series in the U. S. National Museum, as follows: Type lot, Tanner's Canyon, Huachuca Mountains, 26.5, 26.1, 25.9, 24.1, 24, the last two not quite mature. Huachuca Mountains, 25.3 mm. Fort Huachuca, 24.6 mm.

The smallest mature specimen of *S. dalli* slightly exceeds the largest *latior* by 1 mm., and the smallest adult *latior* measures the same as the largest *granulatissima*. *S. mearnsi* Bartsch, from the San José Mountains, 4 miles south of the Arizona boundary, measures 16 mm. diam., being 1.5 mm. smaller than the smallest adult *granulatissima*. It is quite conceivable that *S. dalli* and *S. mearnsi* are merely the extremes of dimensions in a continuous series of variations in size. Since *S. granulatissima* is the only form of the series known anatomically, the ultimate status of the others remains in abeyance. Some or all of them may prove to have valid anatomical specific characters.

Mr. Ferriss did not find *S. dalli*. He thinks that Tanner's is another name for Garden Canyon of the sketch map on p. 212.

***Sonorella virilis* n. sp.** Pl. XVII, figs. 15, 16.

The shell is openly umbilicate; pale brown, lighter around the umbilicus, with a dark band above the periphery, and visible on about $2\frac{1}{2}$ whorls above the suture, with borders a trifle paler than the ground color. Whorls $4\frac{1}{2}$, the earlier $1\frac{1}{2}$ forming a slightly rugose embryonic shell. The next 1 or $1\frac{1}{2}$ whorls are striate, the striae appearing slightly broken into granules. The last whorl has the usual slight growth-lines, and near the end some spiral lines are visible, in the vicinity of the suture. The whorl descends rather deeply, and is well rounded peripherally. The aperture is rather large, oblique and rounded, the upper, outer and basal margins about equally arcuate. The outer and basal margins of the thin lip are slightly expanded. Alt. 11, diam. 19.5, umbilicus 3.1 mm.; aperture 9.3 mm. high, 10 wide.

Chiricahua Mountains, at 7,500 feet elevation, collected by V. Owen. Type 79,622, A. N. S. P.

There are no longitudinal lines on the sole. The pebbly-granose back and the eye-stalks are blackish-gray, becoming much paler dirty brownish-white on the sides and tail. Dorsal grooves are but weakly indicated, and there is no longitudinal median line on the tail.

The kidney is wedge-shaped, 15 mm. long. Pericardium 5.5 mm. long.

Genitalia (Pl. XX, figs. 21, 22). *The penis is relatively enormous*, more than double the length of the vagina, and much longer than the spermatheca and its duct. It has the usual thin wall, enclosing a fleshy "papilla" about 29 mm. long (fig. 21). The epiphallus is also very long, slender and convoluted. The vagina is much convoluted. The spermatheca has the usual globular shape; and its slender duct, while long, is shorter than in other species of equal or greater size.

The jaw (Pl. XXIII, fig. 21) has four broad ribs grouped near the middle.

S. virilis is slightly smaller than *S. hachitana*, with more rounded aperture and weak spiral lines near the suture. From the shell alone I would not separate this form more than varietally from *S. hachitana*; but the enormously developed ♂ reproductive organs indicate one of the most distinct species of the genus. The jaw has few ribs, as in *S. h. bowiensis*. It is not closely related to any other species I have dissected.

The faint spiral lines of the shell are perhaps its most important differential feature.

Several lots collected by Mr. Ferriss in the Chiricahua Mountains resemble *S. virilis* in size, color and sculpture, but differ in having about one-fourth of a whorl more ($4\frac{3}{4}$), and a noticeably smaller aperture. The spiral lines, while visible in some places on all of them, in a favorable light, are often excessively weak. None of them, unfortunately, were sent in the flesh.

In Bar (or Bearfoot) Park, at the summit of the Chiricahuas, the specimens taken show some very weak spiral lines below the last suture.

Alt.	10.7	10.7 mm.
Diam.	18.9	18.7 "

In Sawmill Canyon, Chiricahuas, adjacent to Bearfoot Park, similar shells, diam. 18.7 to 19.9 mm., were taken (Pl. XVII, figs. 17, 18, 19, 20).

Sonorella virilis circumstriata n. subsp. Pl. XVIII, figs. 48-50.

In Cave Creek Canyon, Chiricahuas, the shells are darker throughout, reddish-brown, with a broad very dark chestnut band with wide pale borders, sometimes not very conspicuous. The last whorl shows weak but *distinct spiral engraved lines above the periphery*, in addition to the usual fine growth-striae. The umbilicus varies from about 3.3 to 3.8 mm. in width. A. N. S. P., No. 87,026.

Alt.	11.6	11.3	11	10.8 mm.
Diam.	21	20.3	20	19.5 "
Alt. apert.	9.7	9.2	9	8.9 "
Diam. apert.	10.7	10.4	10	9.5 "

The genitalia (Pl. XX, fig. 19) in two specimens dissected agree in having several minor differences from typical *S. virilis*. The penis, while still extraordinarily large, is only about two-thirds as long as in *virilis*. The vagina is a fourth longer. The epiphallus is the same as in *virilis*.

This form may prove to be connected with typical *virilis* by intermediate stages, in which case the subspecies may prove superfluous; but at present the dark color, more distinct spiral striae, and small aperture of the shell, and the somewhat differently proportioned genitalia, seem worth recording.

Sonorella virilis huachucana n. subsp. Pl. XVII, fig. 24.

Shell slightly more elevated than *S. hachitana*, with *much smaller umbilicus*; more elevated than *S. virilis*, which also is more widely umbilicate; glossy, thin, striate but without granulation. The top of the last whorl, near the aperture, shows *numerous weak spiral incised*

lines. The suprapерipheral band is rather wide and dark, with distinct *white or whitish bands both above and below* it. Above the upper white band the surface is pale reddish to the white sutural line. Below the lower white border the same reddish color prevails, but gradually fades on the base to whitish around the umbilical region. The dark band runs about $2\frac{1}{2}$ whorls up the spire. Apex with sculpture like *S. hachitana*. Whorls $4\frac{3}{4}$, the last rather deeply descending in front. Aperture rounded-oval, the peristome thin, expanded, the dilated columellar end partially covering the umbilicus. Alt. 12.4, diam. 20.6, alt. aperture 10, width 11.5 mm.; width of umbilicus 2.4 mm.

Brown's Canyon, Huachuca Mountains. Type No. 89,225, A. N. S. P., collected by James H. Ferriss, 1904.

This beautiful snail is the only Huachuca form I have seen which seems closely related to *S. virilis*. Unfortunately, the soft parts were not preserved, and its exact relationships are thus uncertain. It is not very unlike *S. hachitana*, but I can see no spiral lines on some of the original lot of *hachitana* before me. The white bordering bands are particularly conspicuous. Only a few were taken by Mr. Ferriss.

In Bear Canyon, Huachuca Mountains, Mr. Ferriss found a few specimens similar to those from Brown's Canyon, but noticeably more depressed, with a smaller mouth and obtuse lip. One measures, alt. 11.5, diam. 20, aperture 9.8 x 11 mm., umbilicus 3 mm. wide. The shell is also somewhat more solid, and the spiral lines are more distinct. In both forms they are readily seen with a hand lens.

Genus **OREOHELIX** Pilsbry.

Helix, *Patula* and *Pyramidula* of authors.

A new genus of *Helicidae*, Pilsbry, Proc. Acad. Nat. Sci. Phila., 1902, p. 511.

Oreohelix Pils., Nautilus, XVII, p. 131, March, 1904.

The shell is umbilicate, varying from discoidal to pyramidal, with 4 to 6 tubular or carinate whorls; earthy, with thin cuticle or none. Embryonic whorls with radial and usually spiral sculpture and carinate periphery. Aperture rounded, oval or angular, oblique, the columellar lip dilated, the outer lip blunt or acute, unexpanded. The sole is undivided. Foot granulose and blackish above or smoothish tessellated with gray. A pair of dorsal grooves is present and usually a distinct genital groove. The tail is depressed above. No parapodial furrows.

The lung has thin-walled venation, chiefly on the cardiac side. *The kidney is short*, but little longer than the pericardium; has a large lumen with coarsely plicate walls, and the usual reflexed ureter. The secondary ureter is closed throughout in the species examined (Pl. XIX, fig. 1, *O. strigosa* var., Pecos, New Mexico).

The penis is well developed, its lower part being muscular, and plicate within, the upper part thinner and densely, finely papillose inside. The epiphallus is well developed, with terminal vas deferens or with a terminal tubercle (representing the flagellum) and a sublaterally inserted vas deferens. The vagina is rather long. The globular or ovate spermatheca terminates a slender duct nearly as long as the uterus. *Reproduction is viviparous.*

The retractor muscle of the penis arises from the apex of the penis and base of the epiphallus, or from the epiphallus near its base, and is inserted on the lung floor. The right ocular retractor passes between the ♂ and ♀ branches of the genitalia.

The jaw is strong, arcuate, its anterior face more or less distinctly striated vertically; and there are sometimes very weak traces of ribs. The radula is of the ordinary Helicid type. In some species the median area has unicuspid teeth, the cutting-edges usually overhanging the sides of the mesocone; while in others distinct ectocones are developed in all the teeth. The marginal teeth are bicuspid, the cusps unsplit as a rule, though there are exceptions where the inner of the two cusps is bifid.

Type *Helix strigosa* Gld. Distribution, Rocky Mountain region from the Canadian to the Mexican boundary.

This dominant type of *Helicidæ* in the area indicated above formerly extended farther east, one species occurring in the loess of Iowa, and there is one outlying species westward, *O. avalonensis* Hemph., on Catalina Island, California. In its present area the type has been interminably modified into local races of all grades of differentiation, *more than fifty of these having received names.*⁶ It is true that in some ranges every canyon—I might almost say every rock-heap—has its own race; but in a broader view it is seen that a single strain usually extends over an entire range with numerous minor modifications, and with increasing elevation a general diminution of size, loss of sculpture and often intensification of color. These reduced forms are probably due to the diminished food supply and especially the shorter growing season in the heights—factors subject to great local variation, even at equal

⁶ The number of species of *Oreohelix* is uncertain. About fifty forms of all degrees of differentiation have been described and named. My treatment of the group in former publications (*Manual of Conchology*, VIII, p. 115, IX, p. 50; *Catalogue of the Land Shells of America*, etc., pp. 31, 32 (1898), was unduly influenced by the views of Binney and Hemphill, both of whom advocated the inclusion of the entire series as varieties of *P. strigosa*. The characters of the shells, penes and teeth indicate, in my opinion, that the species are somewhat numerous; but their notorious variability cautions us to beware of multiplying them without ample materials.

altitudes. To attain a true idea of the relationships of any given alticolous dwarf it is essential to know the forms of the lower canyons of the same region.

The first step toward a fundamental knowledge of the races and species of *Oreohelix* must be the study and definition of races in the broad sense above indicated. In my opinion, the minor modifications can be so overnamed that the wider distinctions become altogether lost, as in the Utah series. The field is vast, and for many years to come there will be plenty of room for work. Anybody who secures a good series of the forms of any district can materially help the cause by working them up.

The sculpture of the embryonic shells and the genitalia seem to afford the most important characters for specific classification. It would take us too far afield to discuss the entire mass of data at hand. This must be reserved for another occasion. Only forms from central and southern Arizona and New Mexico are dealt with below.⁷ The measurements of the genitalia in millimeters follow:

<i>Species</i>	<i>Penis</i>	<i>Epi-phallus</i>	<i>Vagina</i>	<i>Sperma-theca and duct</i>	<i>Diam. of shell</i>	<i>Mus. No.</i>
<i>O. strigosa</i> , Pecos	16.3	6.3	5	21	18.5	85,100
<i>O. elrodi</i>	17	6	8	19	22.5	79,475
<i>O. s. huachucana</i>	14	6.5	5	22	21	83,370
<i>O. barbata</i>	6	4	.....	13	13.5	87,011
<i>O. yavapai</i>	5	3	.....	.....	15-16	79,415
<i>O. y. neomexicana</i>	4	2.1	.....	.....	15	80,700

The species thus far dissected show considerable differences in the genitalia, chiefly in the proportions and shape of the penis, the forms falling into three groups, as follows:

⁷ For comparison with the southern forms I have, however, figured the anatomy of *O. elrodi* (Pils.), from Montana, Pl. XIX, fig. 2. The penis is like that of *O. strigosa*, from Pecos, the lower third having thick walls, densely plicate within; above that the walls are thinner, densely lined with long papillæ, and in the upper third there are several low fleshy ridges, also papillose. There is an extremely short, conic penis-papilla in the apex. The vas deferens enters the epiphallus centrally. The vagina is much dilated and muscular above. The uterus is provided with muscular strands forming an incoherent protractor muscle (fig. 2, r.u.). The embryos were packed in like coins except the two lower ones. The dimensions are given in the table.

1. Penis long, the distal half strongly twisted, there being two distinct kinks, resulting in convolutions variously disposed, and of course not always falling the same in the same species or variety. *O. strigosa*, from Pecos, and *O. elrodi* (Pl. XIX, figs. 3 and 2) belong here.

2. Basal half of the penis swollen and muscular, the distal half smaller, without distinct kinks. *O. s. huachucana* and *O. barbata* (Pl. XIX, figs. 6 and 5) are of this type.

3. Penis small, short, the basal half not much larger than the distal portion, the latter not kinked. *O. neomexicana* and *O. yavapai* (Pl. XIX, figs. 7 and 9) have penes of this kind.

All the above have the penis longer than the epiphallus. In the subgenus *Radiocentrum* the epiphallus is as long as the penis or longer.

As yet my observations have covered only about a dozen of the numerous species and subspecies; and until more of the forms of the central and northern States are examined, characters of the soft anatomy cannot be fully utilized in classification.

There are two types of dentition in *Oreohelix*. The ordinary forms have unicuspid central and inner lateral teeth. Here stand *O. strigosa*, *cooperi*, *newcombiana*, *huachucana*, *yavapai*, *neomexicana* and *haydeni*. In the second type of teeth ectocones are developed on all of the teeth, the centrals being thus tricuspid, the lateral and marginal teeth all bicuspid. Of this kind are *O. idahoensis*, *O. hemphilli*, *O. barbata*, *O. chiricahuana* and *O. clappi*, but in the last species the ectocones are not well developed.

The series of Huachuca *Oreohelices* shows that colonies of the same original stock vary greatly and often show parallel variations in different canyons.

Those from the greatest altitudes are smallest (Pl. XXIV, figs. 25-27, 29-32, Limestone Mountain, 8,000 feet; Pl. XXIV, fig. 28, Carr Canyon, 7,000 feet, etc.), though some large shells occur elsewhere at equal elevations.

Conspicuously banded shells were taken only at high elevations (Pl. XXIV, figs. 17, 18, Brown Canyon, 7,000 feet), plainer ones occurring lower down in the same canyon; but not all the high altitude shells are so marked.

Gerontic or senile individuals or colonies are common, manifested by deep descent of the last whorl in front, with a tendency to form a free or solute peristome (Pl. XXV, figs. 33-35, Ida Canyon).

The carinate periphery is an ancestral character of *O. strigosa* and its allies, present invariably in the neanic stage. It will be noted that

in most colonies there is great individual variation in the extent to which it has been replaced in the adult stage by a rounded periphery.

Oreohelix strigosa (Gld.).

Various forms referable to *strigosa* occur in New Mexico, such as those sent from the Red river (Ashmun), Pecos (Cockerell), Canyon Diablo, near Rowe (Miss Cooper), and Big Spring, 5 miles east of Zuñi (H. S. Conard). They are two-banded, with the periphery of the last whorl rounded, not differing from the forms commonly found farther north, but slightly unlike the typical Northwestern *strigosa*. The exact affinities of these forms await further investigations now in progress.

I have examined the internal anatomy of specimens from Pecos, New Mexico. The shells are either rounded or subangular at the periphery in adults. Sculpture of sharp, irregular growth-wrinkles or striæ, decussated by slightly impressed spiral lines both above and below. The color varies from yellowish Isabelline to light reddish, with paler striæ, always with two narrow bands, and in one specimen a third band around the umbilicus. The embryonic shell is strongly carinate. The first whorl is convex and almost smooth; then fine, regular, obliquely radial striæ appear, and continue to the end of the embryonic shell of 2 to $2\frac{1}{3}$ whorls; over them there is an extremely minute regular spiral striation, and on the last half, whorl coarser, spaced spirals (Pl. XXV, figs. 45, 46, 47).

The specimens examined were taken August 9, 1903. The penis is very long and strongly twisted. The basal third of its length is cylindric, the rest more or less lank, partially collapsed. Internally the basal third (5 mm.) is rather finely plicate longitudinally, thick-walled; the rest has larger lumen and thinner walls, which are densely papillose within, the distal half having three low fleshy internal ridges. The penial retractor is inserted upon the end of the penis and the base of the epiphallus, which is decidedly less than one-half the length of the penis. The vagina is subcylindric. The uterus is distended with embryos, of which there are 9, with shells 3 to 4 mm. in diameter (Pl. XI, figs. 14, 15). Each is enclosed in a membranous capsule, apparently the podocyst. Some of them seem to have a small cephalic vesicle. The other ♀ organs call for no especial notice (Pl. XIX, fig. 3).

The pallial organs have been described above. The kidney is 6.7, the pericardium 4.6 mm. long.

The foot is slate-blackish and finely granular above, the dorsal furrows distinct. The distinct genital furrow is duplicated on the left side.

The jaw (Pl. XXIII, fig. 25) has fine vertical striæ.

The radula (Pl. XXII, figs. 1, 2, 3) has 29.1.29 teeth. Central and inner lateral teeth are unicuspid. An ectocone appears on the eighth or ninth teeth. The marginal teeth are all bicuspid (fig. 2).

Mr. Binney has figured the genitalia of a specimen of *strigosa* from Salmon river. Just what race it belongs to is not positively known. It differs from the Pecos form of *strigosa* by the shorter, apparently untwisted penis. The epiphallus and vagina are also shorter. He figures the teeth of *strigosa* with the ectocone split on an extreme marginal, and the radula had 50.1.50 teeth—a far greater number than I have encountered in this genus. The teeth of *O. haydeni* as figured by Binney are like those of Pecos *strigosa*, and 33.1.33 in number. *O. elrodi* has 28.1.28 similar teeth, the tenth with an ectocone, marginals bicuspid.

Forms referable to *Oreohelix cooperi* have been found by Prof. Cockrell in central New Mexico. None were turned up in the regions explored by Mr. Ferriss.

***Oreohelix strigosa concentrata* (Dall).**

Patula strigosa var. *concentrata* Dall, Proc. U. S. Nat. Mus., XVIII, 1895, p. 1; XIX, p. 336.

This was described from a dwarf form of the mountain tops, the types from the summit of the Huachuca Mountains, Cochise county, Arizona. Through the courtesy of Dr. William H. Dall, I have one of the typical lot (No. 89,237, A. N. S. P., from No. 129,999, U. S. Nat. Mus.), and a series from the top of Hacheta Grande, 9,000 feet elevation (No. 65,742, A. N. S. P.).

1. Typical *concentrata* is white with two dark red-brown bands, the lower one wider, and some livid clouding on the upper surface. The 5 whorls are convex, the last rounded peripherally, with a slight and inconspicuous trace of angulation at its origin. *The umbilicus is widely open, very ample within.* Sculpture of low, rude, nearly effaced wrinkles, with no trace of spiral lines anywhere. The type measures alt. 8, diam. 16 mm., the specimen before me 7.8 x 14.8 mm. with the umbilicus 4 mm. wide.

O. s. concentrata is a relatively evolved form, having lost the keel on the last whorl. The embryonic whorl seems to be similar to that of *huachucana*. There are no spirals on the last whorl. Diam. 14 to 16 mm.

The following lots from the Huachuca seem referable to *concentrata*.

2. Carr Canyon, 7,000 feet (Pl. XXIV, fig. 28). Similar to typical *concentrata*, with the same depressed shape, very ample umbilicus and nearly effaced sculpture, but fine radial ripples are visible on the em-

bryonic whorls in the least worn shells; broadly two-banded with chestnut, blackish in places, the upper band sometimes extending to the suture.

Alt.	9	8.7	10 mm.
Diam.	15.2	15	15 "

3. Limestone Mountain, Huachucas, south side at 8,000 feet elevation (Pl. XXIV, figs. 29-31). The shells are whitish with some fleshy or livid streaks or dots, and with two bands, or clouded and suffused with purple-brown. Similar to typical *concentrata* except that the umbilicus is decidedly smaller within. The last whorl descends to the aperture. They are like *O. s. huachucana*, No. 3, from Brown Canyon, in miniature. They are rounded or slightly angular in front. *The sculpture is subobsolete*, without a trace of spirals.

Alt.	8.9	8.4	9.5 mm.
Diam.	15.2	15.3	15 "
Whorls	5	4 $\frac{3}{4}$	5

Scalariform monsters are not rare, but the inception of that abnormal condition seems to be invariably traceable to an injury of the shell. One such is figured (Pl. XXIV, fig. 31).

4. Limestone Mountain, south side, 8,000 feet. Like the preceding, but more elevated and fleshy white with pinkish apex. The last whorl descends rather deeply (Pl. XXIV, fig. 32).

Alt.	10	9.7	8.7 mm.
Diam.	15.3	15.5	13.7 "

5. Limestone Mountain, north side, 8,000 feet. Similar to the two preceding lots in size and sculpture, but broadly two-banded with purple-black, or entirely of this color (Pl. XXIV, figs. 25, 26, 27). This lot resembles *O. s. huachucana*, Nos. 11, 12, from Carr Canyon, which are also from a high altitude. No. 5 from 7,000 feet, Brown Canyon, has also similar coloring, but is much larger.

This lot, like all seen from Limestone Mountain, does not have the umbilicus so wide within as in typical *concentrata*.

Alt.	9	8.8	9.3 mm.
Diam.	16.3	15.5	15.2 "

6. The series of five specimens sent by Dall as *O. s. concentrata* from Hacheta Grande Mountain, Grant county, New Mexico, one of which is figured on Pl. XXV, fig. 60, shows no appreciable divergence from the

co-type before me, having the same ample umbilicus and blunted sculpture. Whether these shells are to be regarded as really identical with the Huachuca *concentrata*, or as a parallel dwarf race independently evolved, is a question remaining to be determined by a study of the forms from the lower canyons of the Hacheta Grande Mountains.

Oreohelix strigosa huachucana (Pils.). Pl. XXIV, figs. 5-7 (types).

"*Pyramidula*" *strigosa huachucana* Pils., Proc. Acad. Nat. Sci. Phila., 1902, p. 511.⁸

1. The types are from "Conservatory Canyon," otherwise known as Ramsey Canyon, on the northeastern slope of the Huachuclas between Brown and Carr Canyons.

They are depressed with a broad umbilicus, exposing more of the penultimate whorl than *strigosa*,⁹ and it is also more ample within. There are 5 whorls, of which $2\frac{1}{2}$ are embryonic. The tip is a little depressed; the first whorl is delicately striate or wrinkled in an obliquely radial direction. On the second whorl weak raised spiral lines usually set in; and the last embryonic whorl is rather coarsely, irregularly wrinkled radially, and finely striate spirally, with (in some shells) several raised threads on the last half whorl. These cease abruptly at the end of the embryonic stage. The following whorls are irregularly, obliquely wrinkled and have at most obsolete spiral lines or traces of them in places, often almost imperceptible. *The base has no spiral striation as a rule*, but in some specimens from Carr Canyon there are faint spirals there. Up to the end of the fourth whorl the periphery is strongly carinate, but in adult shells it is nearly angular in front, the last half or more becoming rounded. The suture follows the crest of the keel, and usually descends a trifle to the aperture.

The shell is flesh-colored above, with irregular whitish streaks or maculæ; beneath, the opaque white predominates more, and there is a purplish-brown band close to the periphery (but 4 or 5 of 25 examined are equally flesh-tinted beneath, and lack the band, Pl. XXIV, fig. 8). The aperture is small, very oblique, with the ends of the lip approaching. The peristome is not expanded.

Alt. 10.5, diam. 21.8, width of umbilicus 6 mm.; aperture 8.8 mm. wide. Types No. 83,370, A. N. S. P., collected by James H. Ferriss.

The reproductive system of one of the types is figured (Pl. XIX,

⁸ It was evidently this race which Dr. R. E. C. Stearns reported from Fort Huachuca as *Helix (Patula) hemphilli* Newc. (Proc. U. S. Nat. Mus., XVI, 1893, p. 745), and Dall from the Huachuca Mountains, as *P. strigosa* (Proc. U. S. Nat. Mus., XIX, 1896, p. 335).

⁹ The comparisons are with typical *O. strigosa* from the extreme Northwest, which is identical with Hemphill's var. *parva*.

fig. 6). It was taken in February, during the inactive season, and the uterus is quite small. The dimensions of the organs are given in the table (p. 270). The lower half of the penis is much swollen, the upper half smaller and lank. When opened the basal narrower portion is found to have strong acute folds; these become weak in the swollen part, which contains a large fleshy process adnate to the upper side. The contracted upper portion of the penis is papillose inside, with three low ridges.

The retractor muscle and epiphallus are as in *Pecos strigosa*. The ♀ organs show nothing noteworthy.

The radula (Pl. XXII, fig. 5, group of transitional teeth) has 30.1.30 teeth. Those of the median area are much as in *Pecos strigosa*, with overhanging mesocones only. The ectocone begins weakly on the sixth or seventh, and is well developed on the eleventh tooth. The marginal teeth are all bicuspid, the cusps unsplit.

O. s. huachuca is widely distributed in the canyons of the Huachuca Mountains, and nearly every colony has some individual features. "Sometimes only one form was found in a colony, but usually they vary in color and form. They are slow travelers and hence the distinctive characteristics of the colonies. They had not encroached at all upon the ground burned over two years ago. Colonies on different sides of the divides between canyons were entirely different, even when but a hundred or two hundred feet apart" (Ferriss).

Brown Canyon, Huachuca Mountains. Numerous colonies in this canyon vary in color, but in all the periphery of the last whorl may either be rounded, as in the type lot, or the acute keel of the young may extend upon the first third or half. The color-forms of the individual colonies are as follows:

2. Solid, *opaque pinkish-white*, with a few fleshy streaks and scattered dots. Sculpture weak (Pl. XXIV, figs. 9, 10).

3. Similar, but with a narrow band on the upper surface and on the base a band below the periphery, as in the typical form. Frequently the upper surface is largely fleshy-brown. This is an abundant form, differing from the Conservatory Canyon race only in the frequent retention of the keel in adults (Pl. XXIV, figs. 11, 12, 16).

4. Dull brown predominates throughout. Usually there are no bands (Pl. XXIV, figs. 13, 14). This and all the preceding from Brown Canyon are from about 7,000 feet. Some specimens are like the following form. In one gerontic colony at 6,000 feet the peristome is contracted and continuous in old shells (Pl. XXIV, fig. 15).

5. A broad, blackish-chestnut band below the periphery, the rest

of the base whitish, often dotted. Upper surface also dark brown, usually with a light line below the periphery (Pl. XXIV, figs. 17, 18). 7,000 feet elevation.

6. Ramsey Canyon, Huachuca Mountains, collected in 1904, and evidently from a different colony from the types collected in 1902. Two specimens received are dirty whitish. The whorl descends very deeply to the aperture. They are markedly gerontic.

Alt. 9.5, diam. 17.3 mm.

" 10, " 16 "

Carr Canyon, Huachuca Mountains. In this canyon most or all colonies have the form with rounded periphery, and that with it acutely carinate on the first half of the last whorl. The spire is usually sharply striate obliquely, and the last whorl is frequently striate spirally. The special tendencies of this canyon are most strongly expressed in No. 12.

7. Carr Canyon, 5,500 feet. Similar to No. 4, Brown Canyon, except that the sutures are less impressed, nearly level, and margined very distinctly above by the keel. In some shells the last whorl is rather distinctly decussate by spirals above. In one specimen the suture is deeply deflexed above, as in the Ramsey Canyon shells. A basal band is sometimes present.

Alt.	12	10.5	9.8	10.8 mm.
Diam.	21	19.5	18	18 "

8. Carr Canyon, 5,500 feet. One specimen is similar to No. 7; the other three, measured below, are more calcareous, resembling No. 2, but the whorl is deflexed anteriorly (Pl. XXIV, figs. 21, 22, 23). In one the keel extends to the aperture, though rather weakly.

Alt.	10	9.8	8.6 mm.
Diam.	20	18.8	18.8 "

9. Carr Canyon, 6,000 feet (figs. 19, 20). Shells like No. 3, Brown Canyon, but not so white, the ground color being light brown, and the oblique striation sharper. Two specimens show a second band on the base.

Alt.	11	12	11	10 mm.
Diam.	19.8	19	18.7	17.4 "

10. Carr Canyon, 6,000 feet (fig. 24). Similar to the preceding, but the ground is much darker, like No. 4. Diam. 18.6 to 19.5 mm.

11. Carr Canyon, 7,000 feet. *Blackish-chestnut*, the inner whorls

paler; striation sharp; *spirals well developed on the last whorl*; not carinate. Alt. 8.8, diam. 14.7 mm. (Pl. XXV, fig. 36).

This lot is dwarfed, about the size of *O. s. concentrata*.

12. Another lot from Carr Canyon, altitude not stated, contains whitish bandless shells and brownish ones, uniform or banded like No. 7. One is carinated to the aperture and all are keeled in front. The sculpture consists of fine, sharp rib-striae on the spire, and when fresh, young shells show cuticular laminae on the costulae, larger at intervals and at the periphery. The base has a similar sculpture. The last whorl is spirally striate above and below. Diam. 21 mm. (Pl. XXV, figs. 37, 38, 39, 40).

It may be noted that Dall has reported "a sharply carinated variety" from Tanner's Canyon, Huachuca Mountains (*Proc. U. S. Nat. Mus.*, XIX, p. 335).

Mr. Ferriss notes that the young are hirsute. This form diverges quite markedly from *huachucana* and to some extent parallels *O. barbata* of the Chiricahuas. It was found in one small colony only (No. 79 of Mr. Ferriss' coll., 87,132, A. N. S. P.).

13. Miller Canyon, 5,000 feet. Very large, depressed shells with 0, 1 or 2 bands, ground color fleshy-white or brown. Periphery rounded, or in one specimen angular in front (Pl. XXIV, figs. 1, 2, 3, 4, the last immature).

Alt.	14	13.6	13	12 mm.
Diam.	24.5	23	23	21 "

14. Miller Canyon, 5,500 feet. Similar to the preceding.

On the opposite side of the range specimens were taken in Cave Creek and Ida Canyons.

15. Cave Creek Canyon, 5,500 feet. Whitish or brown-banded specimens like Nos. 3 and 4 (Pl. XXV, figs. 41, 42, 43).

16. Ida Canyon. Whitish specimens, angular or rounded in front, and with or without a band. The whorl descends more or less in front, and some gerontic forms occur. Diam. 19.8 to 22 mm. (Pl. XXV, figs. 33, 34, 35).

Oreohelix strigosa metcalfei Ckll. Pl. XXV, figs. 44, 48, 52.

Nautilus, XVIII, p. 113, February, 1905.

The shell is calcareous, whitish with corneous and brownish streaks and dots, and a dark brown band below the periphery. The upper surface is rather rudely wrinkled obliquely, but scarcely shows spirals; but *the base is closely and in most specimens rather distinctly spirally striate*. Embryonic shell like that of *O. s. huachucana*. The whorls have an acute, projecting carina which continues to the aperture, and are

flat above it, forming a straightly conic spire. Suture not impressed. The last whorl descends in front. Aperture rather small, as in *O. s. huachucana*. Umbilicus ample within, as in *huachucana*.

Alt.	12	10.2	10.6 mm.
Diam.	21	19.5	20 "
Whorls	4 $\frac{3}{4}$	5 $\frac{1}{4}$	5 $\frac{1}{2}$

Mountains near Kingston, Sierra county, New Mexico, collected by O. B. Metcalfe.

This form stands close to the *huachucana* series, from which it differs only in the spiral striation of the base, which is usually quite distinct though very minute,¹⁰ and in the persistence of the peripheral keel to the aperture. In the last feature it is less evolved than *huachucana*. In some specimens of the latter the keel also persists, though less strongly.

***Oreohelix strigosa socorroensis* n. subsp.** Pl. XXV, figs. 49-51.

The shell is thin, with 2 $\frac{1}{2}$ embryonic whorls closely and *sharply obliquely striate*, with a few low, coarse, indistinct spirals on the last embryonic whorl. Whorls 4 $\frac{1}{2}$ to 4 $\frac{3}{4}$, convex, the later ones rudely but not coarsely wrinkled, without noticeable spirals above, but *the base is very densely and distinctly striate spirally*. The last whorl is quite convex above and below a cord-like peripheral keel, which extends nearly or quite to the aperture. The last whorl descends a little and slowly in front. The umbilicus is rather small, but enlarges at the opening. Aperture as usual.

Alt.	8	9.2	8	8.8 mm.
Diam.	15	14.8	13.5	13.3 "

Negra Mountains, Socorro county, New Mexico. Types No. 58,128, A. N. S. P., presented by Dr. W. D. Hartman, collector unknown.

Related to *O. s. metcalfei*, its neighbor on the south, but that is a more strongly carinate shell with flat whorls and straightly conic spire. They agree in the beautiful circular striation of the base.

***Oreohelix barbata* n. sp.** Pl. XXV, figs. 57, 58.

The shell is broadly and openly umbilicate, depressed, biconvex, carinate, pale brown, lusterless; obliquely closely lamellose costulate, the lamellæ lengthened into a cuticular fringe at the periphery, and at several places on the base, forming circular fringes there. A similar

¹⁰ In some specimens of *huachucana* from Carr Canyon, such as Pl. XXV, fig. 36 and figs. 37-40, the base is spirally striate, but it is not so in *huachucana* from other places.

but less developed one runs in the middle of the upper surface of the last whorl. The embryonic shell of nearly two whorls is not distinctly defined from the subsequent growth; the first whorl is smoothish with some radial wrinkles only; the second is densely obliquely costulate, with cuticular lamellæ on the fine riblets in perfectly preserved examples. There are weak traces of a few coarse, low spirals. Whorls 4, rather rapidly increasing, the last slowly descending in front, very convex beneath. The aperture is very oblique, shortly pear-shaped, the peristome simple, upper and lower margins much converging and straightened, connected by a short and thin parietal callous.

Alt. 7, diam. 13.5 mm., not including the cuticular processes.

Cave Creek Canyon, Chiricahua Mountains, Arizona, collected by J. H. Ferriss. Co-types No. 87,011 and 87,146, Coll. A. N. S. P. It lives in a moist situation, in stone talus near the falls of the stream.

Cuticular processes or "hairs" are generally present on the shells of very young *Oreohelices*, but in this one alone their development culminates in the adult snail. Their projection at the angle of the whorls of the spire makes the lamellæ look continuous over the sutures. When denuded the shell is sharply striate, with some ill-defined spirals marking the positions of the more prominent cuticular wreaths. Besides those described above, there are some minor and variable spirals on the most perfect specimens.

The processes are very efficient as gatherers of soil, which is probably glued on by the mucous of the animal, as usual. In the general plan of ornamentation, this bearded *Oreohelix* is not unlike *Polygyra* (*Stenotrema*) *pilsbryi* Ferriss.

By its tricuspid central and bicuspid lateral teeth, as well as by the general form of the shell, *O. barbata* recalls *O. hemphilli*, especially when denuded of the "beard." The embryonic sculpture is not very unlike some forms of *hemphilli*, but it most resembles that of *O. s. socorroensis*, though a little coarser. The insertion of the penis retractor solely on the epiphallus is like *Radiocentrum*, and unlike any of the typical *Oreohelices*.

The foot of *O. barbata* is small, slate-blackish above, and finely granulated. No genital furrow is discernible, but there is a pair of dorsal grooves. The tail is flattened and pale above. The mantle edge is very thick and fleshy.

The genitalia of one of the types are figured (Pl. XIX, fig. 5). The penis resembles that of *S. strigosa huachucana*, the lower half being much swollen, the upper half smaller and cylindric. Internally the larger portion has 4 or 5 large and some smaller longitudinal folds, the

upper part is densely papillose inside. The epiphallus bears the penis-retractor muscle, some distance from its base, and the vas deferens enters centrally at the end. The duct of the spermatheca is somewhat swollen basally. The uterus contained neither eggs nor embryos, the specimens having been collected in February.

The radula (Pl. XXII, fig. 6) has 23.1.23 teeth. The mesocones are long, and *all the teeth have well-developed ectocones*. The marginal teeth are bicuspid as usual, the cusps unsplit.

Oreohelix yavapai n. sp. Pl. XXV, fig. 53.

Shell thin, whitish more or less stained with brown, with a faint brown band above and another close below the periphery. The small peripheral keel extends to the aperture, but is pinched up less than in *neomexicana*; the last whorl elsewhere is well rounded, the earlier whorls flattened. Embryo of $2\frac{1}{2}$ whorls, the first nearly smooth, convex, the next more flattened, finely, densely striate obliquely, and *very strongly striate and ribbed spirally*. At the end of the embryonic stage this *spiral sculpture abruptly stops*, and is succeeded by sharp oblique striation which becomes cut by a few spiral lines. On the last whorl there are more spirals, usually emphasized as series of granules or pits upon the oblique striæ (indicating cuticular processes in perfectly fresh shells). Whorls about $5\frac{1}{2}$, the last hardly descending in front. The umbilicus is ample, as in *O. y. neomexicana*. Aperture oblique, rounded, with thin lip.

Alt.	8.7	9.5 mm.
Diam.	15.2	16.6 “

Purtyman's ranch, on Oak creek, Yavapai county, about 40 miles from Jerome, Arizona (northwest of the center of the Territory), types No. 79,415, A. N. S. P., collected by E. H. Ashmun. Also found on the summit of Mt. Mingus, near Jerome, and fossil in a road cutting in Walnut Gulch, near Jerome (Ashmun).

Dr. R. E. C. Stearns reported a form probably identical with *O. yavapai* from Coon Mountain, a curious crater about 10 miles south of Canyon Diablo, and about 3 days' travel from Flagstaff, Arizona (*Patula strigosa* Gld., *Nautilus*, VI, May, 1892, p. 1; *Proc. U. S. Nat. Mus.*, XVI, p. 745).

The embryonic young shells, 2 mm. diameter with $2\frac{1}{2}$ whorls, are acutely carinate (Pl. XI, fig. 13).

This species differs from *O. strigosa* in the form of the shell, which is more like *O. hemphilli*, and by the diminutive penis, while the epiphallus is longer in proportion than in forms of *strigosa* I have exam-

ined ; it differs from *O. y. neomexicana* chiefly by the stronger spiral sculpture of the embryonic shell and the abrupt change in sculpture at the inception of the neanic growth. The same differences and the wider umbilicus separate it from the northern *O. hemphilli*, which, moreover, differs by its dentition, as indicated below under *O. y. neomexicana*.

The penis (Pl. XIX, fig. 7) resembles that of *O. y. neomexicana* except that it is larger, and the vas deferens enters the epiphallus centrally at the apex. There were 10 embryos in the uterus, each half enveloped in its podocyst.

The jaw has longitudinal and vertical striæ. The radula (Pl. XXII, figs. 7) has 26.126 teeth, those in the middle unicuspid; the ectocone distinctly appearing on the sixth. Marginal teeth bicuspid, the cusps unsplit.

Oreohelix yavapai neomexicana n. subsp. Pl. XI, figs. 8, 9; Pl. XXV, fig. 59.

The shell is thin, brown, acutely keeled, pinched in above and below the peripheral keel, which extends to the aperture, the whorls elsewhere convex above and below. Embryo of 2 to $2\frac{1}{3}$ whorls, convex except near the periphery where they are impressed; they are densely striate obliquely and rather obsoletely striate spirally. The junction with the subsequent neanic growth is often indistinct. Whorls $4\frac{3}{4}$ to $5\frac{1}{4}$, the later ones rudely, very obliquely wrinkled, and showing raised spiral striæ, usually rather indistinct. The umbilicus is ample within and rather widely open, exposing the penultimate whorl. Aperture small with simple lip, the whorl descending slowly to it.

Alt.	8.5	7.8 mm.
Diam.	15.6	14.5 "

Canyon Diablo, near Rowe, San Miguel county, New Mexico. Types No. 84,297, A. N. S. P., collected by Miss Mary Cooper.

This form differs from *O. hemphilli* (Newc.) by its less convex embryonic whorls, which are more impressed near the periphery, and by the more ample umbilicus; but it differs chiefly by the unicuspid teeth of the median part of the radula, those teeth in *O. hemphilli* having well-developed ectocones, as in *O. barbata*. It seems to be rather widely separated geographically from the range of *O. hemphilli*.

It is also before me from Beulah, in the Sapello Canyon, San Miguel county, at 8,000 feet (Prof. Cockerell), small specimens only 10 mm. diameter, with $4\frac{1}{2}$ whorls, perhaps not quite adult. Similar small specimens come from Las Huartes Canyon, Bernalillo county, New Mexico (Miss Cooper).

I have partially examined the internal anatomy of one of the specimens from Beulah. The penis (Pl. XIX, fig. 9) is bent in the middle, the lower half a little swollen, with muscular walls, the upper half slightly smaller, softer. There is a very small apical papilla, and the retractor muscle is inserted at the apex of the penis and root of the epiphallus. The epiphallus is large, shorter than the penis, and the vas deferens enters at the side, not the center of the apex.

The radula has 19.1.19 teeth, similar to those of *O. yavapai*. On the fifth or sixth teeth the ectocone is developed. Marginals bicuspid, as usual.

Subgenus *RADIOCENTRUM* nov.

Oreohelices with an embryonic shell of $1\frac{1}{2}$ radially ribbed whorls, spiral striæ in the intervals between ribs excessively weak or wanting. Penis rather short, with a hollow dilation at the distal end. Epiphallus club-shaped, as long as the penis, the retractor inserted near its base. Type *O. chiricahuana* Pils.

This group differs from *Oreohelix* by the smaller number of embryonic whorls and their different sculpture, and in the somewhat different structure of the penis. It includes at present three species: *O. chiricahuana*, *O. clappi* and *O. avalonensis*.

The genitalia are similar in the two species examined, the only difference being in the shape of the distal end of the penis, and in the absolute dimensions. The pallial organs of *O. clappi* do not differ from those described above for *Oreohelix strigosa*.

Key to Species of Radiocentrum.

- a.*—Shell bluntly subangular or almost rounded at the periphery; covered with a green or olive cuticle, largely worn from old shells.
Alt. 8.5 to 9.7, diam. 15 mm., *O. clappi* Ferriss.
- a'.*—Shell carinated; earthy, without perceptible cuticle.
 - b.*—"Whorls $4\frac{1}{2}$, granulated above and below, the last one wide; aperture large. Alt. 6, diam. 11 mm." (*Hemphill*).
O. avalonensis Hemphill.
 - b'.*—Whorls 5, striated but not granulated, slowly widening; aperture small. Alt. 6.5, diam. 11 mm.,
O. chiricahuana Pils.

Oreohelix chiricahuana n. sp. Pl. XI, figs. 1, 2, 3.

The shell is depressed, the altitude about .6 of the diameter, about equally convex above and below the peripheral keel. Umbilicus rather well-like, slowly contracting, and contained five or six times in the diameter of the shell. Whitish, with an indistinct gray band near

the middle of the upper surface and another immediately below the white keel, the early whorls dull brown; without perceptible cuticle. Sculpture of close but irregular and rather sharp growth-wrinkles, very indistinctly decussated with spiral striæ. The embryonic shell consists of *only* $1\frac{1}{2}$ whorls. The first half whorl is nearly smooth, the next whorl is *sharply and finely but very regularly ribbed radially*. With the compound microscope some very weak spiral striation may be seen indistinctly in the intervals. At the end of the embryonic period the rib sculpture abruptly gives place to a lower, less regular oblique striation. The spire is convexly conic. Whorls 5, convex, impressed above the suture, where the keel projects a trifle. At the periphery the keel projects somewhat, the surface being a little concave above and below it. Base convex. Aperture small, oblique, a little angular at the outer part. Lip simple, the ends approaching.

Alt. 6.5, diam. 11 mm.

“ 7, “ 10.5 “

Cave Creek Canyon, Chiricahua Mountains. Types No. 87,012, A. N. S. P., collected by James H. Ferriss. “Occurred on a dry, clay hillside, under dead vegetation and stones, and was found nowhere else on the mountain.”

This is a very distinct little species, closely related to *O. avalonensis* Hemphill of Santa Catalina Island, California, which has an apex of the same type. *O. avalonensis* differs, however, by its conspicuously decussate surface, wider last whorl and larger aperture, and it has a half whorl less. It is figured for comparison, Pl. XI, figs. 4, 5, 6, 7. The umbilicus is about equal in the two species.

O. chiricahuana differs conspicuously from *O. yavapai* and *O. y. neomexicana* by its peculiar apical sculpture, etc.

The genitalia are figured (Pl. XIX, fig. 4). The penis is cylindric, a little flattened and protruding on one side at the distal end. The epiphallus is longer than the penis, club-shaped, the retractor inserted upon it not far from its base. The lower part of the spermatheca duct is enlarged and muscular. The lengths of the organs are as follows: penis 4, epiphallus 4.7, vagina 3.5, spermatheca and duct 7.5 mm. The foot is scarcely granulose, the integument smoothish, tessellated in rather coarse pattern with blackish or gray spots. No genital furrow is visible. The mantle edge is thin.

The jaw (Pl. XXIII, fig. 24) is striate, somewhat less arcuate than that of *O. clappi*.

The radula (Pl. XXII, figs. 10, 11) has 26.1.26 teeth. They are rather shorter than usual in *Oreohelix*. The central and lateral teeth

have well-developed ectocones. The marginal teeth are bicuspid, as usual in *Oreohelix*, but the inner cusp is split.

Oreohelix clappi Ferriss. Pl. XI, fig. 12; Pl. XXV, figs. 54-56.

Nautilus, XVIII, p. 53 (September, 1904).

This is a remarkable snail, slightly resembling *Pyramidula solitaria* on a small scale, but very different from any other *Oreohelix* by its rapidly narrowing umbilicus and green or olivaceous cuticle.

The smoothish integument is blackish on the head and tail, and darker toward the foot margins, elsewhere tessellated with large polygonal gray pigment spots. Sole cream colored. There are two irregular dorsal grooves.

The kidney, 6.3 mm. long, is a thin-walled sack, its lumen large, with strongly corrugated walls. The pericardium is fully 4 mm. long.

The reproductive system (Pl. XIX, fig. 8) resembles that of *O. chiricahuana*. The rather slender cylindric penis is enlarged at the summit, the protuberance on the upper side (in the figure) hollow. The epiphallus enters through a very small acorn-shaped papilla. The walls of the penis are thin, with a minute oblique corrugation meeting V-like on one side. The penis measures 7, epiphallus 7, vagina 6, spermatheca and duct 13 mm. long. The penis retractor is inserted about 1.5 mm. from the base of the epiphallus.

The jaw (Pl. XXIII, fig. 26) is arcuate and striate vertically.

The radula (Pl. XXII, fig. 4) has about 29.1.29 teeth, of the general form usual in *Oreohelix*. There are rudimentary ectocones on the central teeth, at least where they are unworn. The laterals have similar outer cutting points. The marginal teeth are bicuspid. In general, the teeth are between the unicuspid type and that with developed ectocones.

EXPLANATION OF PLATES XI-XXVII.

PLATE XI.—Fig 11 was drawn by the author; the others are reproduced from photographs.

Figs. 1-3—*Oreohelix chiricahuana* Pils. $\times 3\frac{1}{2}$. Co-types.

Figs. 4-6.—*Oreohelix avalonensis* Hemph. $\times 3\frac{1}{2}$. Santa Catalina Island, California.

Fig. 7.—*O. avalonensis*. Early whorls. $\times 6$.

Fig. 8.—*Oreohelix yavapai neomexicana* Pils. Young specimen. $\times 3$. Showing embryonic whorls and two neanic whorls.

Fig. 9.—*O. y. neomexicana*. Segment of base. Only the coarser spirals are visible in the half-tone cut.

Fig. 10.—*Sonorella granulatissima* Pils. No. 87,087. Miller Canyon. Portion of last whorl above the periphery. $\times 7$.

Fig. 11.—*Ashmunella angulata* Pils. No. 87,113. Immature shell of 8 mm. diameter showing temporary lip-rib.

- Fig. 12.—*Oreohelix clappi* Ferriss. Early whorls. $\times 6$. Sculpture is very imperfectly shown.
 Fig. 13.—*Oreohelix yavapai* Pils. Young shell, showing embryonic whorls and about one-third of the first neanic whorl. $\times 6$.
 Figs. 14, 15.—*Oreohelix strigosa* Gld. Pecos, N. M. Uterine young. $\times 6$. The very fine, even spiral striation is not sufficiently enlarged to be visible in the reproduction, though shown in the photograph; the radial ripples are also largely lost.

PLATE XII, Figs. 1-4.—*Ashmunella rhyssa* Dall. Sierra Blanca. Nos. 73,561 and 73,575.

- Figs. 5, 6.—*Ashmunella rhyssa miorhyssa* Dall. Sierra Blanca, New Mexico. No. 73,577.
 Figs. 7, 8.—*Ashmunella rhyssa hyporhyssa* Ckll., larger form. James Canyon, Clouderoft, New Mexico. No. 89,201.
 Figs. 9-13.—*A. r. hyporhyssa* Ckll. James Canyon, Clouderoft. No. 83,345.
 Fig. 14.—*Ashmunella altissima* Ckll. Co-type. Summit of Sierra Blanca. No. 73,558.
 Figs. 15, 16.—*Ashmunella pseudodonta* Dall. White Oaks, New Mexico. No. 73,589.
 Figs. 17, 18.—*A. pseudodonta* Dall. Capitan Mountains, New Mexico. No. 79,529.
 Figs. 19, 20.—*Ashmunella ashmuni* Dall. Bland, New Mexico. No. 73,599.
 Figs. 21-23.—*A. pseudodonta capitanensis* A. and C. Capitan Mountains, New Mexico. No. 74,556.
 Figs. 24-26.—*A. ashmuni robusta* Pils. Bland, New Mexico. No. 73,576.

PLATE XIII, Figs. 23-26.—*Ashmunella esuritor* Pils. Types.

- Figs. 27, 28.—*Ashmunella thomsoniana* (Ancey). Part of the original lot, from J. H. Thomson. Santa Fé Canyon, New Mexico. Nos. 58,113 and 58,114.
 Fig. 29.—*A. thomsoniana*. Specimen from Monument Rock, Santa Fé Canyon. Prof. Cockerell and Miss Porter. No. 77,870.
 Fig. 30.—*A. thomsoniana*. Santa Fé Canyon. E. H. Ashmun. No. 76,709.
 Figs. 31-34.—*A. thomsoniana* (Anc.). Las Vegas Hot Springs, New Mexico. Nos. 84,293, 80,750 and 83,946. Fig. 34 is a co-type of *A. t. cooperæ* Ckll.
 Figs. 35-37.—*A. thomsoniana* (Anc.). Canyon Diablo, near Rowe, New Mexico. No. 84,295.
 Fig. 38.—*A. t. pecosensis* Ckll. Type. Vallé ranch, Pecos, New Mexico. No. 84,209.
 Figs. 39-41.—*A. t. porterae* Pils. and Ckll. Sapello Canyon, San Miguel county, New Mexico, 8,000 feet altitude. No. 81,983.
 Figs. 42, 46.—*A. t. porterae* P. and C. Co-types. Beulah, Upper Sapello Canyon. No. 76,789.
 Figs. 43-45.—*A. t. porterae* P. and C. Pecos, New Mexico. No. 85,099.

PLATE XIV, Figs. 47-49.—*Ashmunella levettei angigyra* Pils. Types. Conservatory Canyon, Huachuca Mountains. No. 83,269.

- Figs. 50, 54.—*A. l. angigyra*. Brown's Canyon. No. 87,093.
 Figs. 51-53.—*A. l. angigyra*. Foothills, Bear Canyon. No. 89,202.
 Figs. 55-57.—*Ashmunella angulata* Pils. Types. South fork of Cave creek, at base of mountain, Chiricahua Mountains. No. 87,019.
 Fig. 58.—*A. angulata*. South fork of Cave creek, under cliffs; showing weak upper branch of the parietal tooth. No. 87,015.
 Figs. 59, 60.—*A. angulata*. Cave Creek Canyon. No. 87,020.
 Fig. 61.—*A. angulata*. Cave Creek Canyon. No. 87,111.
 Fig. 62.—*Ashmunella mearnsi* Dall. Huachuca Mountains. No. 65,736.
 Figs. 63, 64.—*Ashmunella angulata* Pils. Falls of Cave Creek. No. 87,112.
 Figs. 65, 66.—*Ashmunella proxima* Pils. Types. Sawmill Canyon, Chiricahua Mountains. No. 86,498.
 Figs. 67-69.—*Ashmunella fissidens* Pils. Cave Creek Canyon, Chiricahua Mountains. Types. No. 87,022.
 Figs. 70, 71.—*A. proxima*. Topotypes. No. 87,102.

PLATE XV, Figs. 72-75, 79.—*Ashmunella levettei* (Bld.). Typical. Bear Canyon, Huachuca Mountains, 6,500 feet. No. 87,089.

Figs. 76.—*A. levettei*. Albino. Head of Bear Canyon, 7,000 feet. No. 87,098.

Fig. 77.—*A. levettei*. Pathologic monster, same locality.

Fig. 78.—*A. levettei*. Miller Canyon, Huachuca Mountains, 6,000 feet. No. 87,099.

Figs. 80-88.—*A. l. heterodon* Pils. Ida Canyon, Huachuca Mountains. No. 89,203.

Figs. 89-91.—*A. l. heterodon*. Cave Creek Canyon, Huachuca Mountains. No. 87,152.

Figs. 92, 93.—*A. levettei*, var. approaching *angigyra*. Carr Canyon, Huachuca Mountains, 5,000 feet. Nos. 87,092 and 89,204.

Figs. 94, 95.—*A. l. heterodon* Pils. or *chiricahuana* Dall(?), Miller Canyon, Huachuca Mountains. No. 87,097.

PLATE XVI, Figs. 96-99.—*Ashmunella chiricahuana* (Dall). Cave Creek Canyon, Chiricahua Mountains. No. 87,096, A. N. S. P.

Fig. 100.—*A. chiricahuana*. An elevated specimen from the same locality. No. 87,021.

Fig. 101.—*A. c. mogollonensis*. Base of a larger specimen from Kingston, Sierra county, New Mexico.

Fig. 102.—*Ashmunella chiricahuana mogollonensis* Pils. West fork Gila river, near Mogollon Peak, New Mexico. No. 79,530.

Figs. 103-107.—*Ashmunella duplicidens* Pils. Bearfoot Park, Chiricahua Mountains. No. 87,024.

Figs. 108-110, 113.—*Ashmunella ferrissi* Pils. Cave Creek Canyon, Chiricahua Mountains. No. 89,232.

Figs. 111, 112, 117.—*Ashmunella walkeri* Ferriss. Co-types. Florida Mountains, near Deming, New Mexico.

Figs. 114, 115.—*Ashmunella metamorphosa* Pils. Types.

Fig. 116.—*Ashmunella mearnsi* (Dall). No. 65,736.

PLATE XVII, Figs. 1, 2.—*Sonorella hachitana*, var. Florida Mountains, No. 87,078.

Figs. 3-6.—*Sonorella hachitana*, var. Florida Mountains. No. 86,496.

Figs. 7, 8.—*Sonorella hachitana*, var. Organ Mountains. No. 71,413.

Figs. 9-14.—*Sonorella hachitana ashmuni* Bartsch. Purtyman's. Nos. 79,409 and 80,707.

Figs. 15, 16.—*Sonorella virilis* Pils. Type. Chiricahua Mountains. No. 79,622.

Figs. 17-20.—*Sonorella virilis* Pils., var. Sawmill Canyon, Chiricahua Mountains. No. 87,081.

Figs. 21-23.—*Sonorella granulatissima* Pils. Types. No. 83,257.

Fig. 24.—*Sonorella virilis huachucana* Pils. Brown Canyon, Huachuca Mountains.

PLATE XVIII, Figs. 24-28.—*Sonorella granulatissima latior* Pils. Brown's Canyon, Huachuca Mountains. No. 87,083.

Figs. 29-32.—*Sonorella hachitana bowiensis* Pils. Fort Bowie. No. 86,497.

Figs. 33, 34.—*Sonorella rowelli* (Newc.). Sanfords. No. 83,273.

Fig. 35.—*Sonorella rowelli* (Newc.). Patagonia Mountains. No. 83,268.

Figs. 36-38.—*Sonorella granulatissima* Pils. Ida Canyon. No. 87,088.

Figs. 39, 40, 44.—*Sonorella granulatissima* Pils. Miller Canyon. No. 87,087.

Figs. 41-43.—*Sonorella granulatissima* Pils. Miller Canyon. No. 89,227.

Figs. 45-47.—*Sonorella granulatissima parva* Pils. West end of Huachuca Mountains. No. 87,114.

Figs. 48-50.—*Sonorella virilis circumstriatus* Pils. Types. Cave Creek Canyon, Chiricahua Mountains. No. 87,026.

Figs. 51-54.—*Sonorella granulatissima* Pils. Carr Canyon, Huachuca Mountains. No. 89,226.

PLATE XIX.—Anatomy of *Oreohelix*.

- Fig. 1.—*Oreohelix strigosa*, from Pecos, New Mexico. Pallial complex.
 Fig. 2.—*O. elrodi* (Pils.).
 Fig. 3.—*O. strigosa* (Gld.), from Pecos, New Mexico.
 Fig. 4.—*O. chiricahuana* Pils.
 Fig. 5.—*O. barbata* Pils.
 Fig. 6.—*O. s. huachucana* Pils.
 Fig. 7.—*O. yavapai* Pils. Penis.
 Fig. 8.—*O. clappi* Ferriss.
 Fig. 9.—*O. y. neomexicana* Pils. Penis.

PLATE XX [all figures $\times 2$], Fig. 10.—*Sonorella hachitana bowiensis* Pils. Penis opened to show papilla. Bowie, Arizona. No. 86,497.

- Fig. 11.—*S. h. bowiensis* Pils. Genitalia of same specimen.
 Fig. 12.—*Sonorella hachitana* (Dall). Genitalia of individual from Florida Mountains, New Mexico. No. 86,496. The penis-papilla shows faintly through.
 Fig. 13.—*Sonorella rowelli* (Newc.). Penis opened to show papilla. Sanford's, Arizona. No. 83,273.
 Fig. 14.—*S. rowelli* (Newc.). Genitalia of same individual.
 Fig. 15.—*Sonorella hachitana ashmuni* (Bartsch). Opened penis of a specimen from Purtyman's ranch, Oak creek, New Mexico. No. 79,409.
 Fig. 16.—*Sonorella granulatissima* Pils. ♂ organs, showing epiphallus and flagellum of one of the type specimens. Spring Canyon, Huachuca Mountains.
 Fig. 17.—*S. granulatissima* Pils. Genitalia of same individual.
 Fig. 18.—*S. granulatissima* Pils. Opened penis of same individual.
 Fig. 19.—*Sonorella virilis circumstriata* Pils. Genitalia of No. 87,026. Cave Creek Canyon.
 Fig. 20.—*Sonorella rowelli* (Newc.). Terminal ducts of genitalia of a small form from the Patagonia Mountains, Arizona. No. 83,268.
 Fig. 21.—*Sonorella virilis* Pils. Opened penis of type specimen. Chiricahua Mountains. No. 79,622.
 Fig. 22.—*S. virilis* Pils. Genitalia of same specimen.

PLATE XXI.—Genitalia of *Ashmunella*.

- Fig. 23.—*Ashmunella duplicitens* Pils. $\times 2\frac{3}{4}$. No. 87,024.
 Fig. 24.—*Ashmunella proxima* Pils. $\times 2\frac{3}{4}$. No. 86,498.
 Fig. 25.—*Ashmunella esuritor* Pils. Exserted penis.
 Fig. 26.—*Ashmunella angulata* Pils. $\times 2\frac{3}{4}$. No. 87,015.
 Fig. 27.—*Ashmunella metamorphosa* Pils. $\times 2$. No. 88,885.
 Fig. 28.—*Ashmunella l. angigyra* Pils. $\times 2\frac{3}{4}$. No. 83,269.
 Fig. 29.—*Ashmunella chiricahuana* Pils. $\times 2$. No. 87,021.
 Fig. 30.—*Ashmunella esuritor* Pils. $\times 2\frac{3}{4}$. No. 87,023.

PLATE XXII, Figs. 1, 2, 3.—*Oreohelix strigosa*, variety from Pecos, New Mexico.

1. Central tooth *r*, with three laterals; 2. Group of marginal teeth at the edge of radula; 3. Lateral and transitional teeth.
 Fig. 4.—*Oreohelix clappi* Ferriss. Central and two lateral teeth of a co-type.
 Fig. 5.—*Oreohelix strigosa huachucana* Pils. Group of lateral and transitional teeth of a type specimen.
 Fig. 6.—*Oreohelix barbata* Pils. Central tooth with laterals i-iii, vi and vii of a co-type.
 Fig. 7.—*Oreohelix yavapai* Pils. Co-type. Group of lateral and transitional teeth, with a central tooth on the extreme right.
 Fig. 8.—*Ashmunella metamorphosa* Pils. Central with two adjacent lateral teeth of a type specimen.
 Fig. 9.—*Ashmunella angulata* Pils. No. 87,015. Group of transitional and marginal teeth.
 Figs. 10, 11.—*Ashmunella chiricahuana* (Dall). Group of central and lateral teeth and two groups of marginal teeth of a typical specimen.
 Fig. 12.—*Ashmunella levettei angigyra* Pils. Conservatory Canyon, Huachuca Mountains. Half row of teeth, some of the marginals omitted.

PLATE XXIII.—Jaws of *Ashmunella*, *Sonorella* and *Oreohelix*.

- Fig. 13.—*Ashmunella chiricahuana* Dall. Cave Creek Canyon, Chiricahuas. No. 87,021.
 Fig. 14.—*Ashmunella levettei angigyra* Pils. Type. No. 83,269.
 Fig. 15.—*Ashmunella angulata* Pils. No. 87,015.
 Fig. 16.—*Ashmunella metamorphosa* Pils. Co-type.
 Fig. 17.—*Ashmunella levettei proxima* Pils. Co-type. No. 86,498.
 Fig. 18.—*Sonorella rowelli* (Newc.). Patagonia Mountains, Santa Cruz county, Arizona. No. 83,268.
 Fig. 19.—*Sonorella hachitana* var. Organ Mountains, New Mexico. No. 71,413.
 Fig. 20.—*Sonorella hachitana* (Dall). Florida Mountains, New Mexico. No. 86,496.
 Fig. 21.—*Sonorella virilis* Pils. Type. No. 79,602.
 Fig. 22.—*Sonorella h. bowiensis* Pils. Type. No. 86,497.
 Fig. 23.—*Sonorella granulatissima* Pils. Co-type.
 Fig. 24.—*Oreohelix chiricahuana* Pils. Co-type.
 Fig. 25.—*Oreohelix strigosa* Gld. var. Pecos, New Mexico.
 Fig. 26.—*Oreohelix clappi* Ferriss. Co-type.

PLATE XXIV, Figs. 1-4.—*Oreohelix strigosa huachucana*. Miller Canyon, 5,000 feet. No. 87,144.

- Figs. 5-7.—Conservatory Canyon. No. 83,370. Type specimens.
 Fig. 8.—Uniform brown specimen. Same locality. No. 83,371.
 Figs. 9, 10.—Brown's Canyon, at 7,000 feet. No. 87,125.
 Figs. 11, 12, 16.—Brown's Canyon, at 7,000 feet. No. 87,124.
 Figs. 13, 14.—Brown's Canyon, at 7,000 feet. No. 87,126.
 Fig. 15.—Brown's Canyon, at 6,000 feet. No. 87,122.
 Figs. 17, 18.—Brown's Canyon, at 7,000 feet. No. 87,127.
 Figs. 19, 20.—Carr Canyon, at 6,000 feet. No. 87,135.
 Figs. 21-23.—Carr Canyon, at 5,500 feet. No. 87,134.
 Fig. 24.—Carr Canyon, at 6,000 feet. No. 87,136.
 Figs. 25-27.—*O. s. concentrata* (Dall). Limestone Mountain, north side, at 8,000 feet. No. 87,128.
 Fig. 28.—*O. s. concentrata* (Dall). Carr Canyon, 7,000 feet. No. 87,138.
 Figs. 29-31.—*O. s. concentrata* (Dall). Limestone Mountain, south side, at 8,000 feet. No. 87,131.
 Figs. 32.—*O. s. concentrata* (Dall). Limestone Mountain, south side, at 8,000 feet. No. 87,131.

PLATE XXV, Figs. 33, 34.—*Oreohelix s. huachucana* Pils. Ida Canyon, Huachuca Mountains, 7,000 feet elevation. No. 87,143.

- Fig. 35.—*O. s. huachucana* Ida Canyon, 7,000 feet. No. 87,142.
 Fig. 36.—*O. s. huachucana*. Carr Canyon, 7,000 feet. No. 87,137.
 Figs. 37-40.—*O. s. huachucana*, keeled and hirsute form. Carr Canyon. No. 87,132.
 Figs. 41-43.—*O. s. huachucana*. Cave Creek Canyon, 5,500 feet. No. 87,140, 87,141.
 Figs. 44, 48, 52.—*O. s. metcalfei* Ckll. Co-types, 44 and 48 from bleached specimens, 52 from one collected alive.
 Figs. 45-47.—*O. strigosa* (Gld.). Pecos, New Mexico. No. 85,100.
 Figs. 49-51.—*O. strigosa socorroensis* Pils. Co-types. No. 58,128.
 Fig. 52.—*O. s. metcalfei* Ckll.
 Fig. 53.—*O. yavapai* Pils. Co-type. No. 79,415.
 Figs. 54-56.—*O. clappi* Ferriss. Co-types. No. 87,013.
 Figs. 57, 58.—*O. barbata* Pils. Co-types. No. 87,011.
 Fig. 59.—*O. y. neomexicana* Pils. Co-type. No. 84,297.
 Fig. 60.—*O. s. concentrata* (Dall). Hacheta Grande Mountain, at 9,000 feet. No. 65,742.

PLATE XXVI, Figs. 1-5.—*Holospira goldfussi* (Mke.). Guadalupe river, about six miles above New Braunfels, Texas. Nos. 89,209, 89,210.

Fig. 6.—*Holospira cockerelli* Dall. Near Kingston, New Mexico. No. 89,211.

Fig. 7.—*Holospira regis* Pils. and Ckll. Near Kingston, New Mexico. No. 89,208.

Fig. 8.—*Holospira crossei* Dall. Hacheta Grande Mountain, Grant county, New Mexico, No. 65,738.

Fig. 9.—*Holospira chiricahuana* Pils. Fort Bowie, Cochise county, Arizona. No. 87,118.

Figs. 10-15.—*Holospira roemeri* (Pfr.). Hondo river, about two miles north of Hondo, Medina county, Texas. No. 89,207.

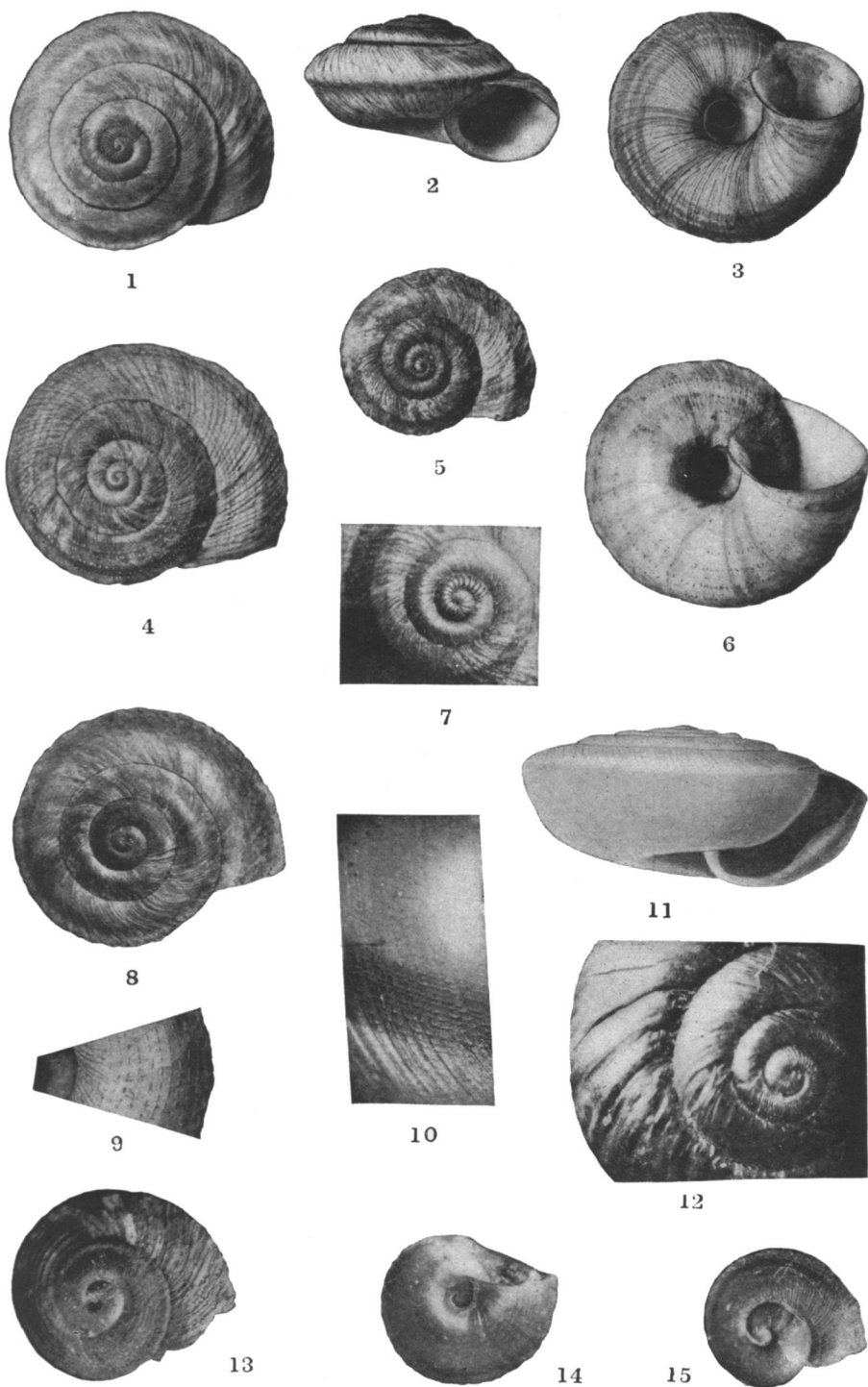
Figs. 16-18.—*H. roemeri*. High Bridge of the Pecos river, Valverde county, Texas. No. 89,206.

Figs. 19-21.—*Microceramus texanus* (Pils.). Guadalupe river, above New Braunfels, Texas. No. 89,205.

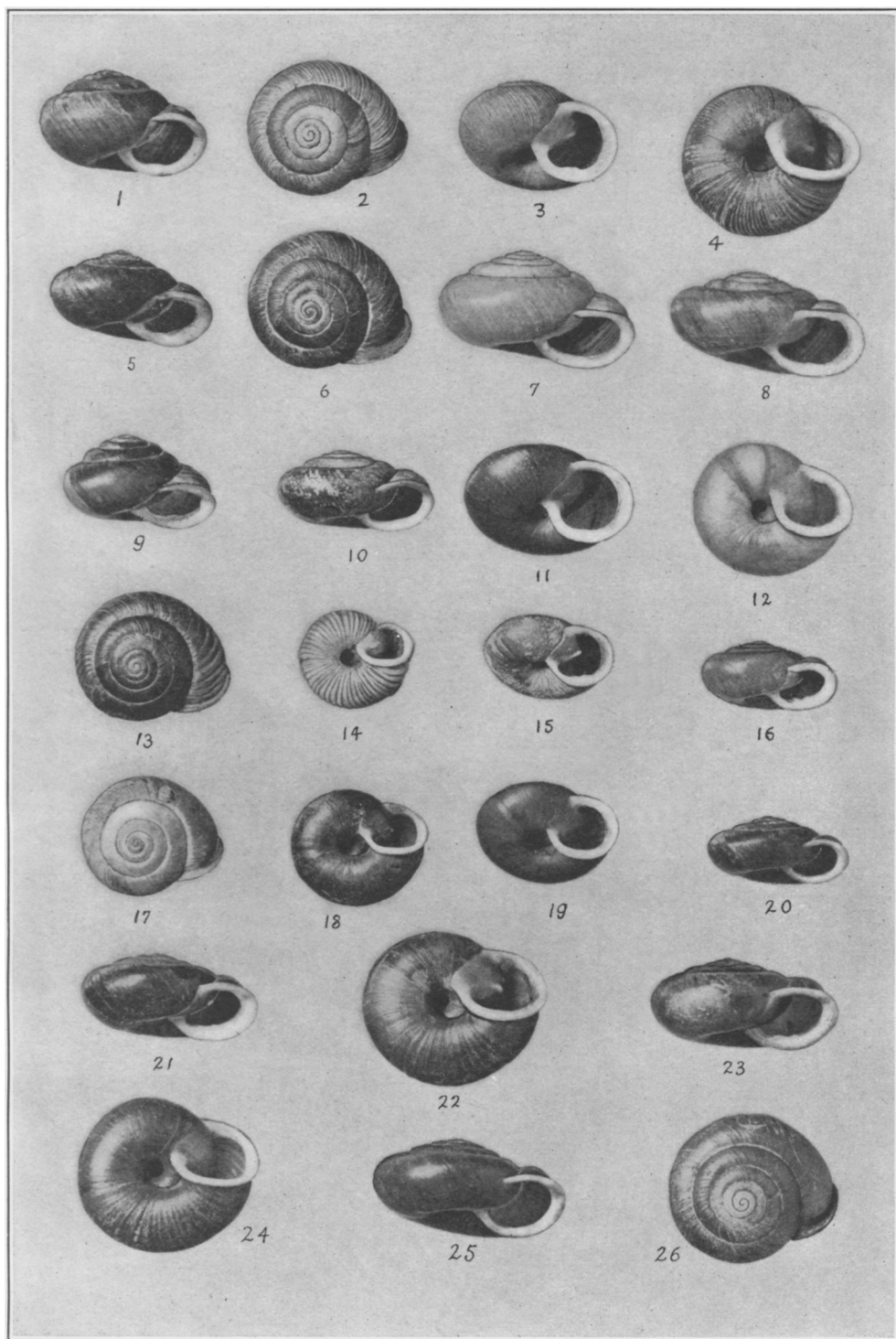
PLATE XXVII, Figs. 22-25.—*Holospira ferrissi* Pils. Manilla Mine, Huachuca Mountains. No. 87,115.

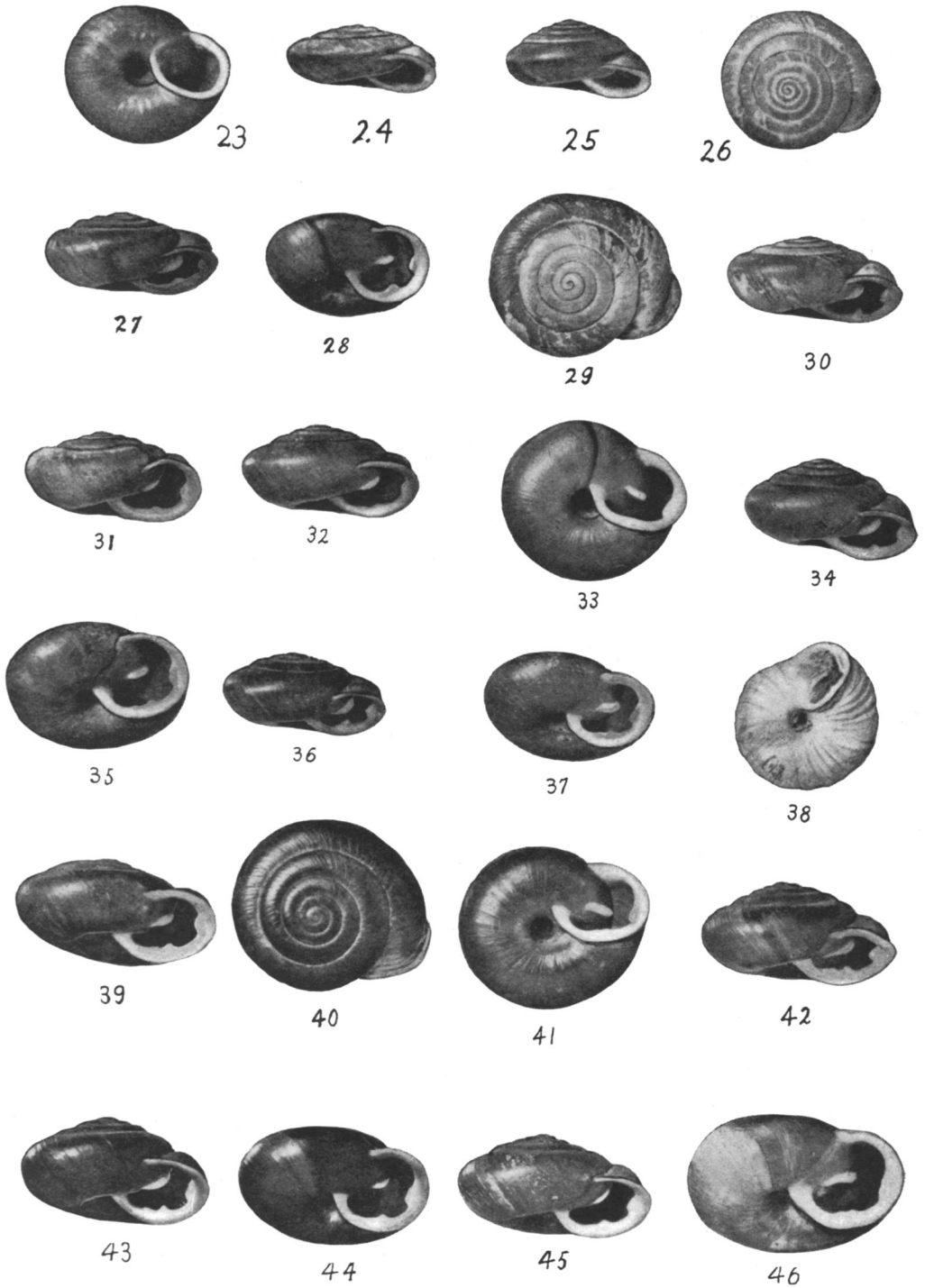
Figs. 26-29.—*Holospira chiricahuana* Pils. Cave Creek Canyon, Chiricahua Mountains. No. 87,119.

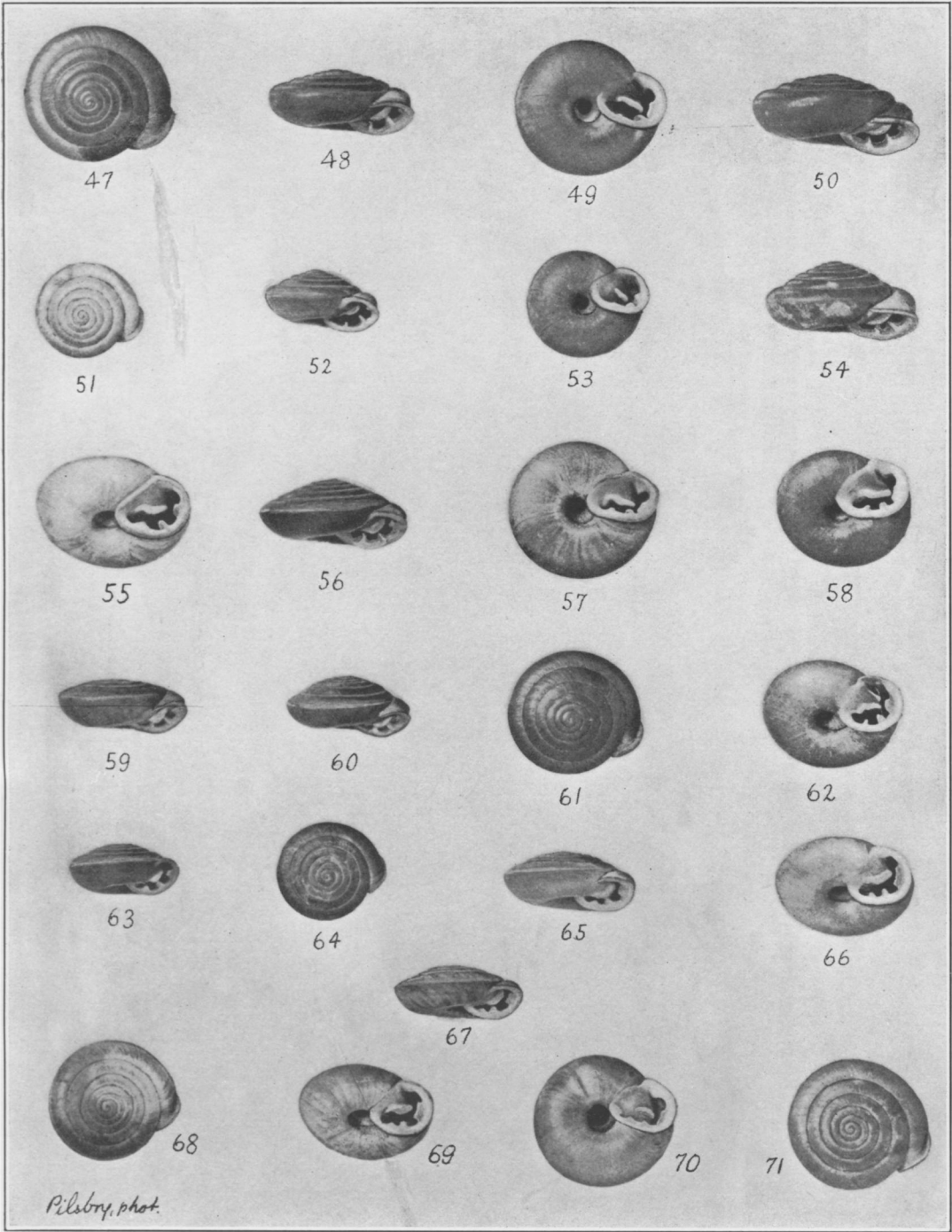
Figs. 30-33.—*Holospira cionella* Pils. Fort Bowie. No. 87,117.



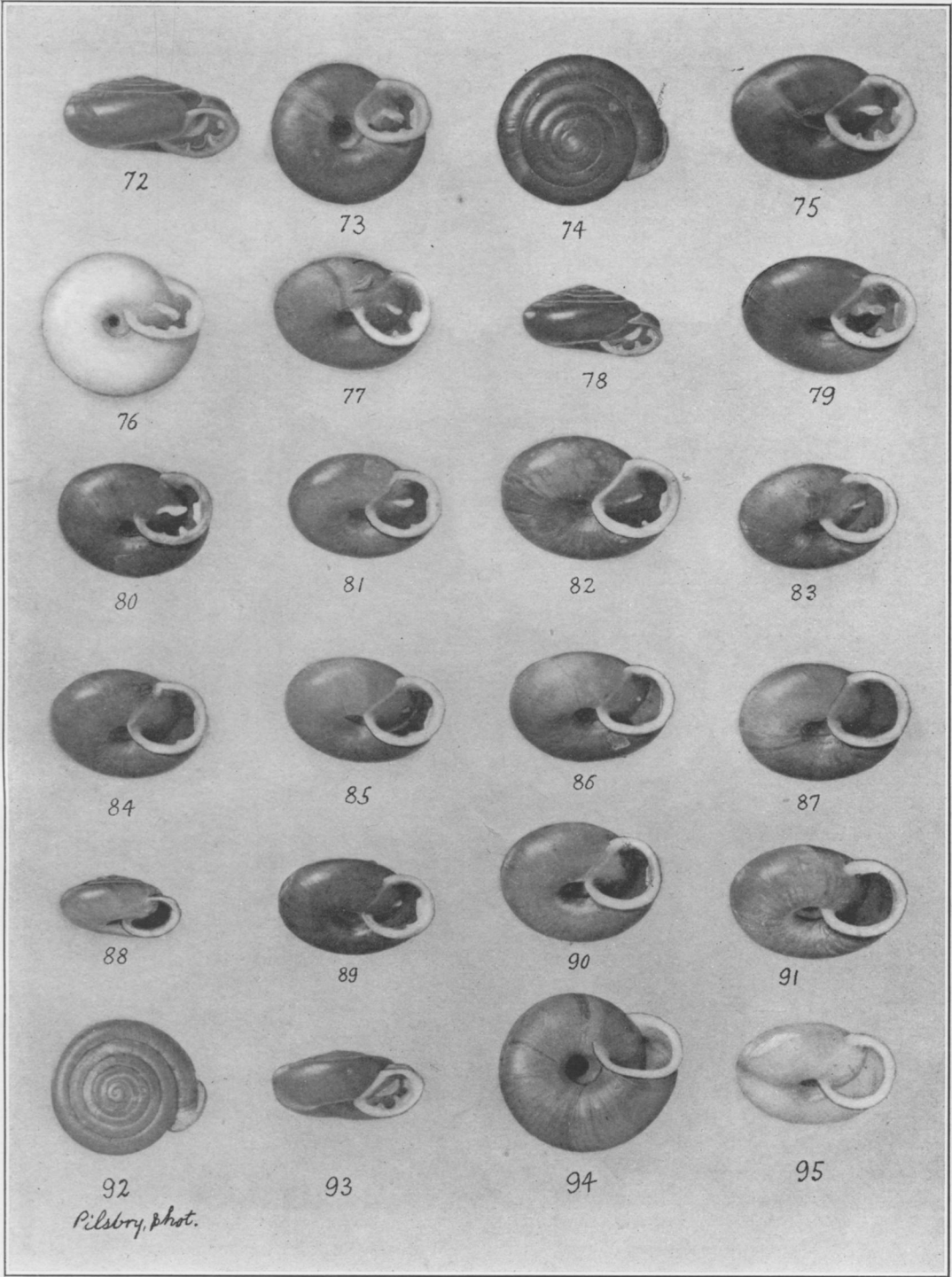
PILSBRY. MOLLUSCA OF THE SOUTHWESTERN STATES.



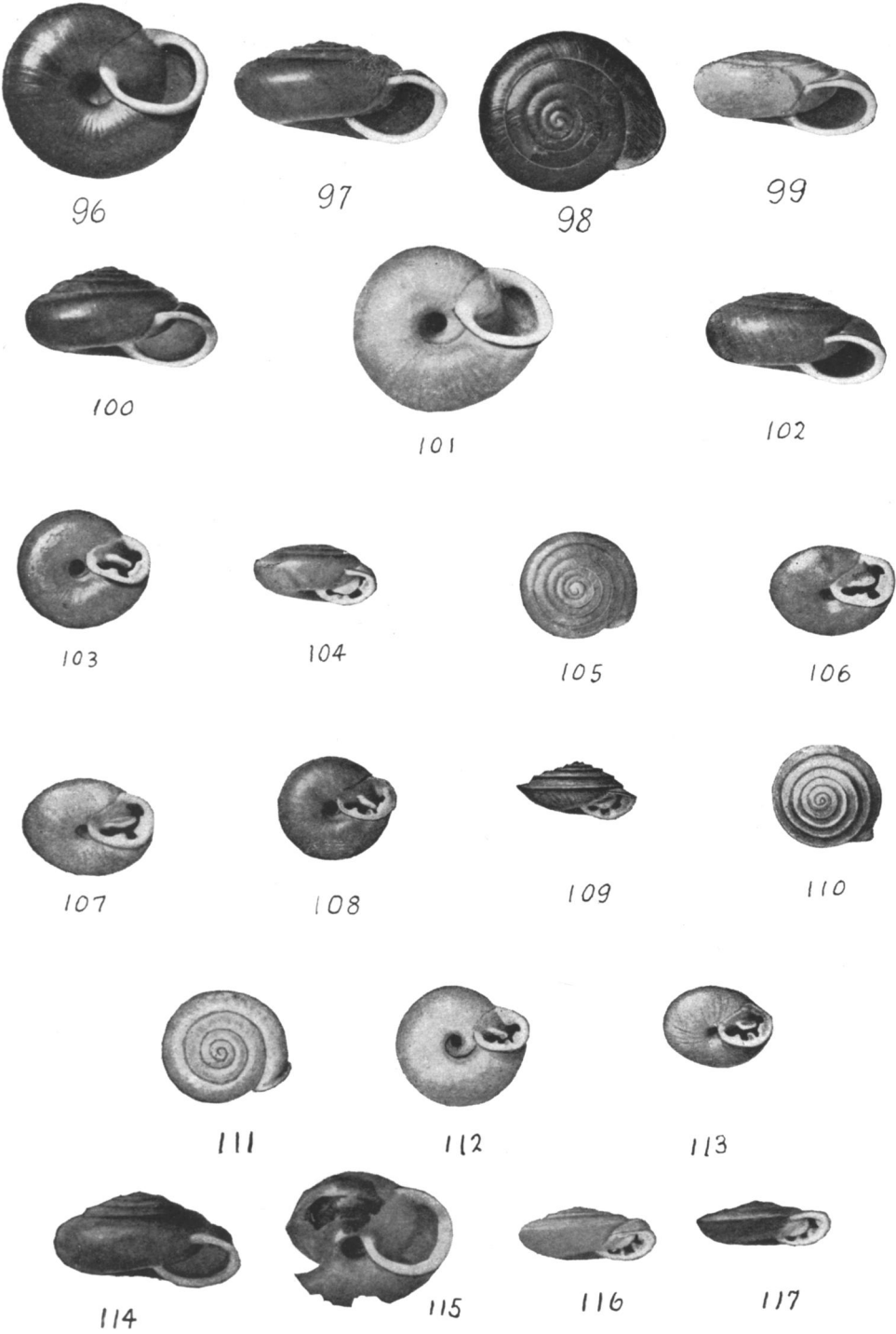


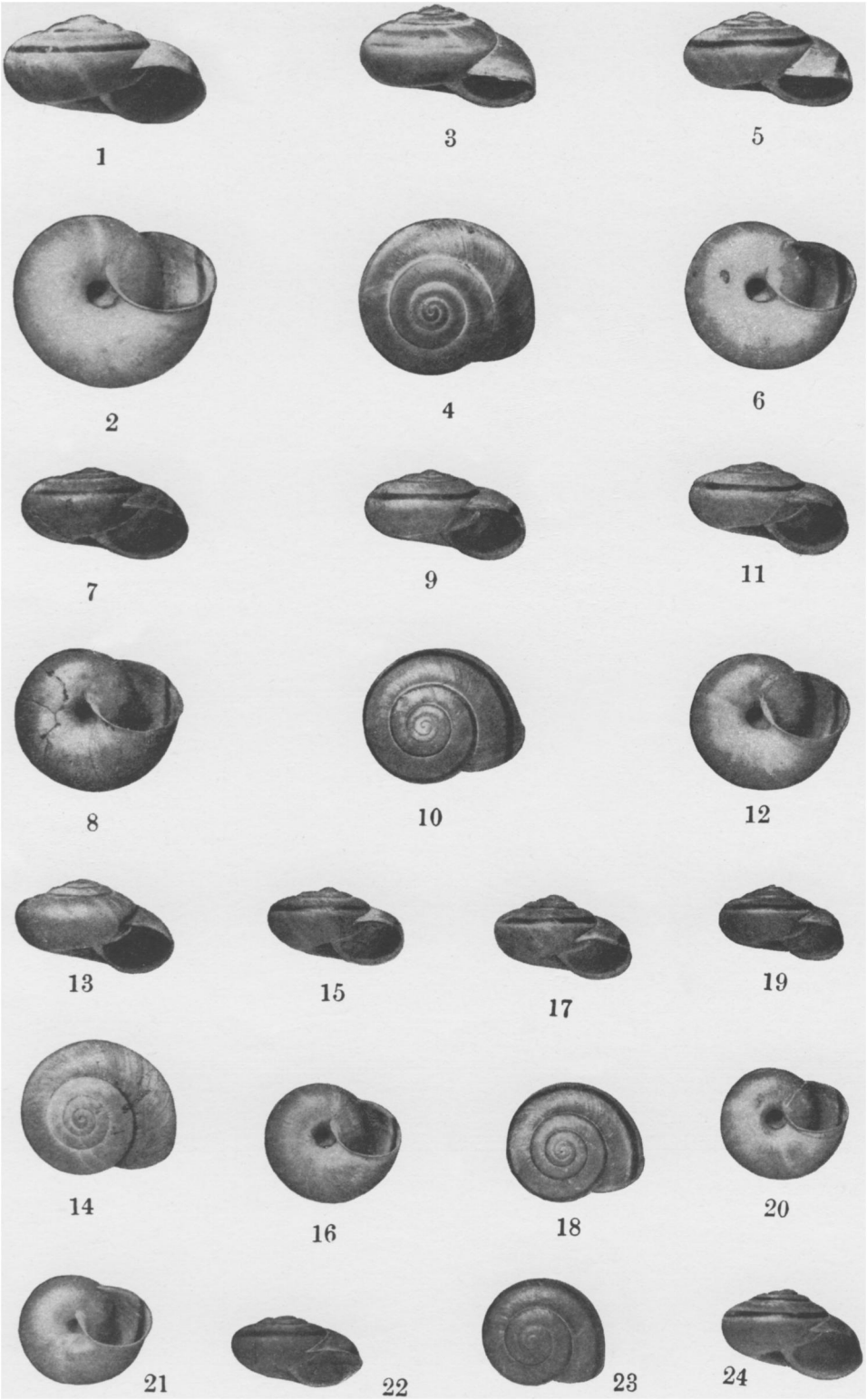


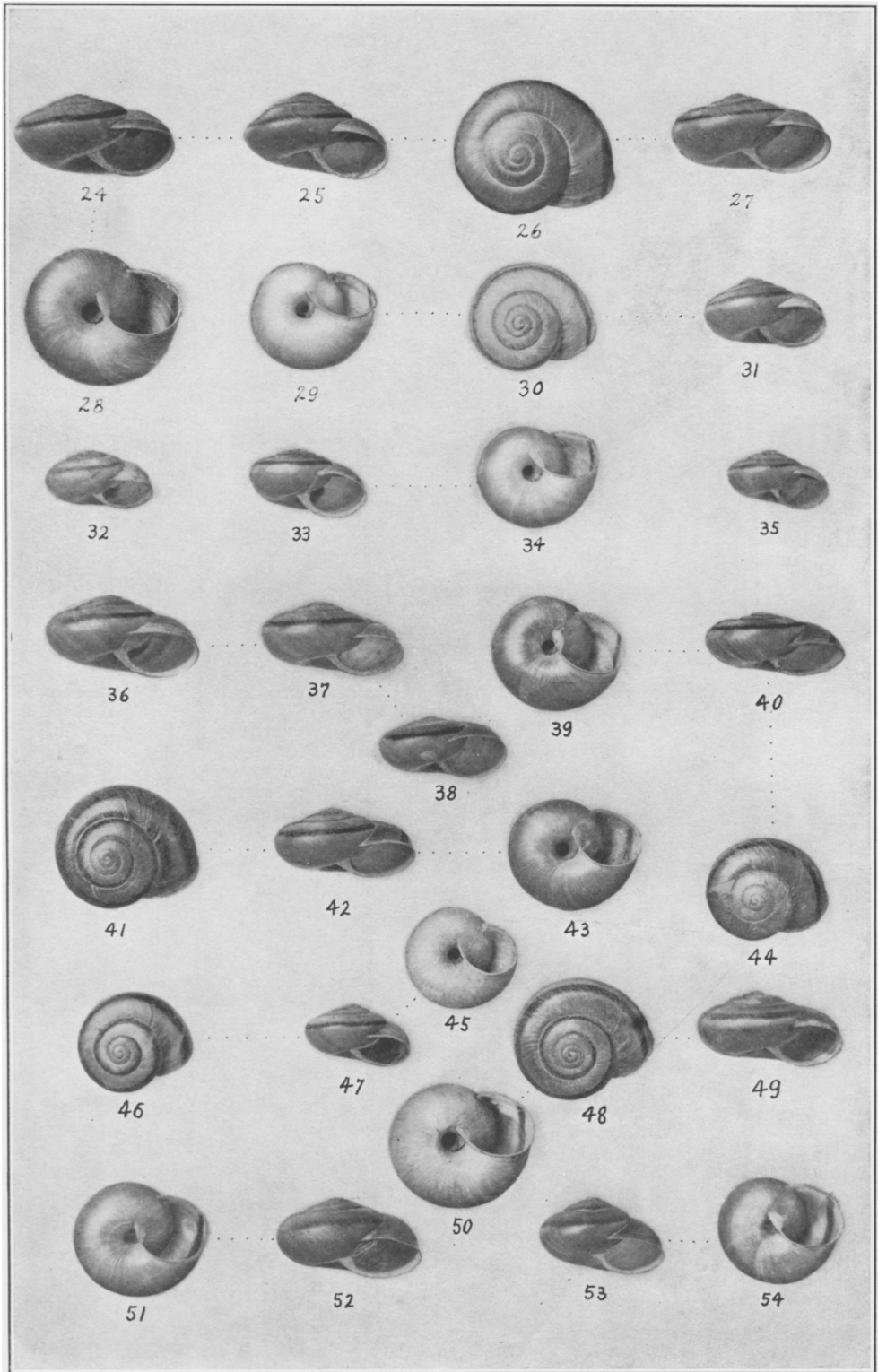
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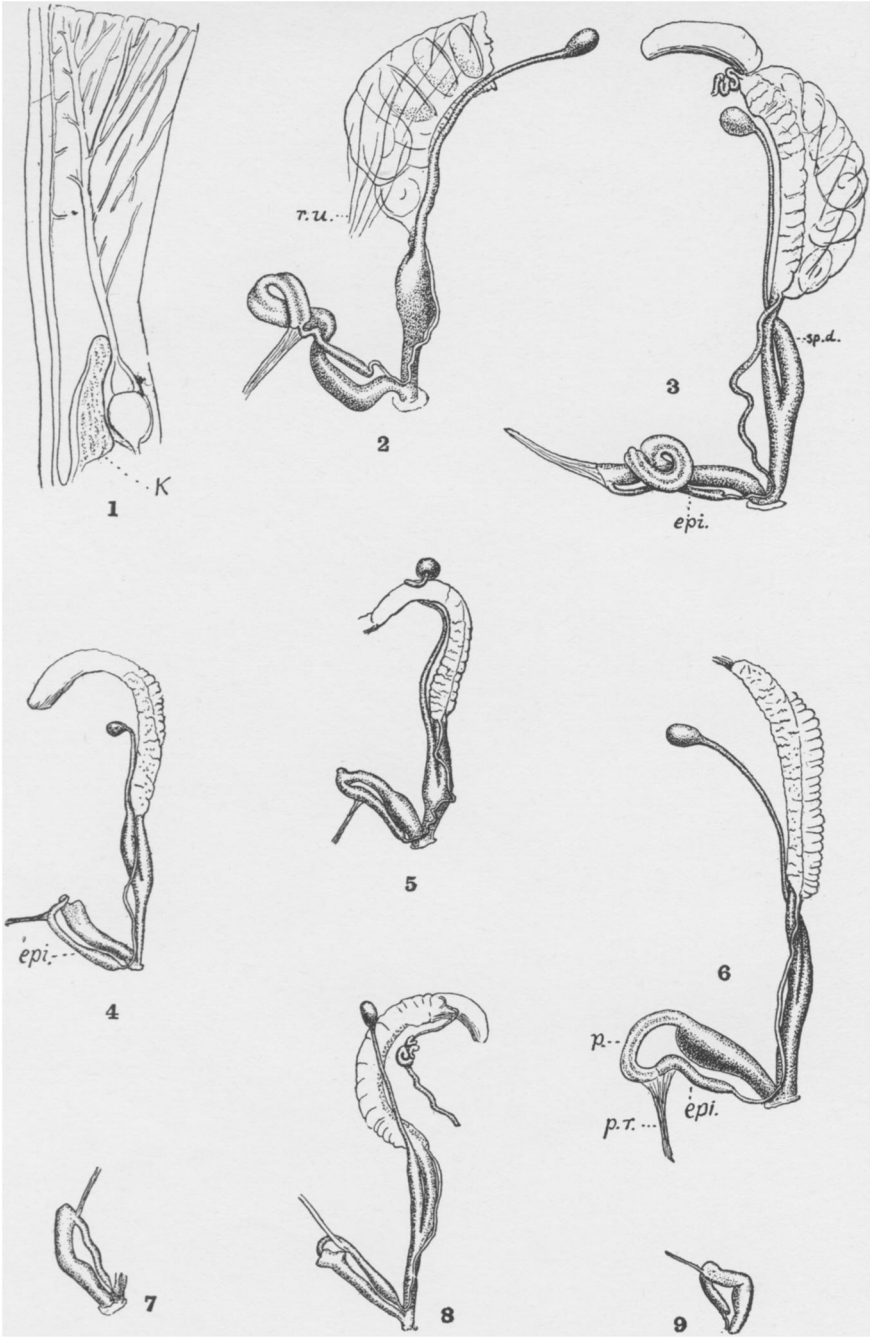


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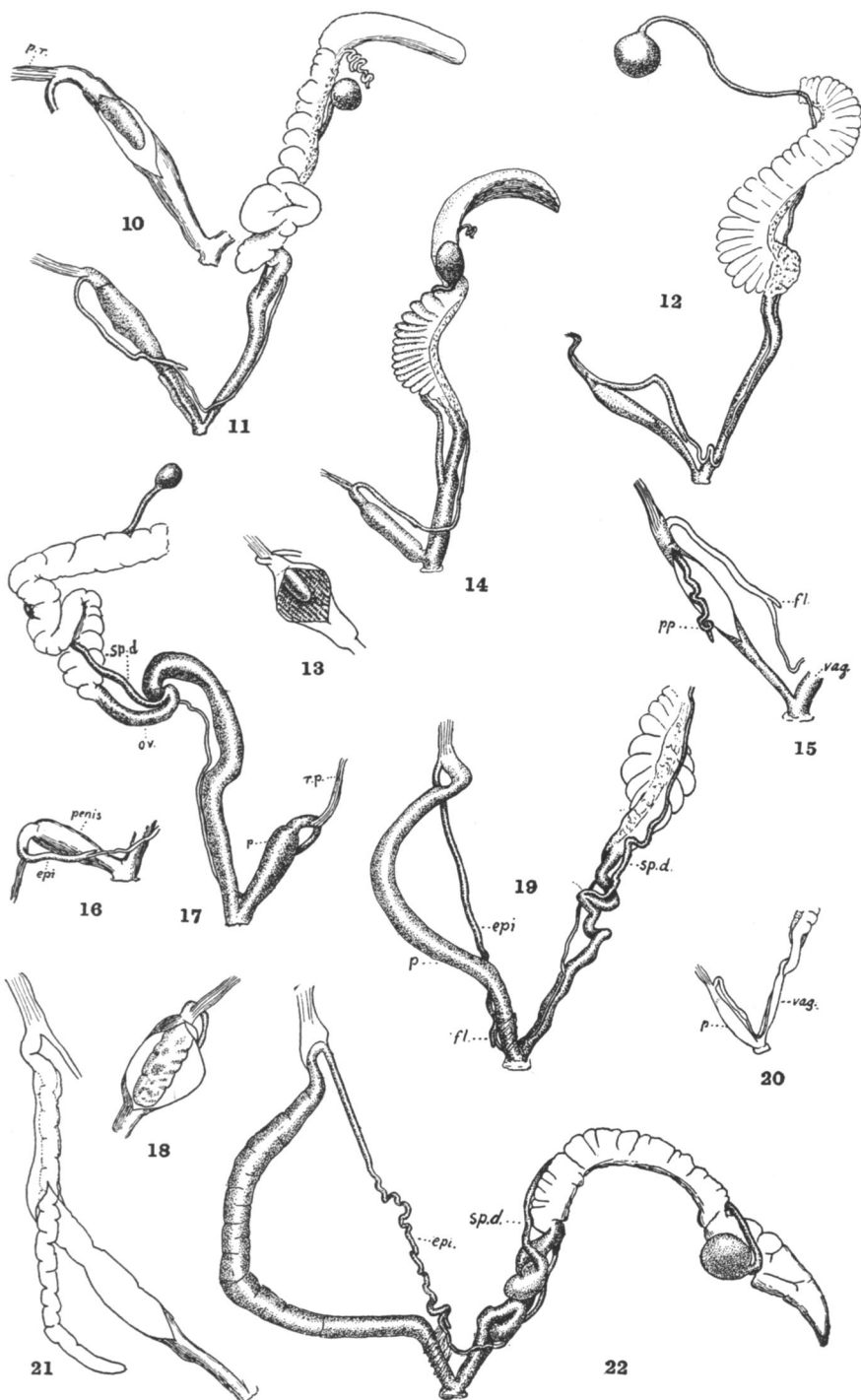








Pilsbrya



Pilsbry del.

